STEEL CONSTRUCTION

AMERICAN INSTITUTE
OF
STEEL CONSTRUCTION
INC.

STEEL CONSTRUCTION

First Edition
Fifth Printing
Fifty-fifth Thousand

April, 1929

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Price $1.50

PREFACE

FIRST EDITION

THIS volume combines the information contained in our previous publications. Considerable new material has been added, and the data regarding the new sections recently produced by the various rolling mills is complete up to the date of publication.

We are also including, a Specification for Fireproofing, which has been prepared for us by a committee of well known engineers. This Specification together with the data derived from tests of insulating material will make possible the designing of the fireproofing for a structural steel frame on a rational basis and supplant the empirical procedure of the past.

New paragraphs have been added to our Code of Standard Practice, and other slight revisions made, which our experience indicates to have been desirable.

The general arrangement of the tabular information regarding the Dimensions, Functions, and Allowable Load for Structural Steel Shapes is now well known. It has been most favorably commented upon, particularly on account of the ease with which the desired information can be found. With this in mind, we have endeavored to design and group all the additional tabular data.

The arrangement of tables to provide the maximum convenience required related data to appear on opposite pages thus causing a few single blank pages. For the convenience of the user these pages have been ruled with cross section lines for notes and diagrams.

A list of General Contents appears on Page 4, and there is a complete index at the back of the book.

GENERAL CONTENTS

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Part I

Standard Specifications

Specification of the American Institute of Steel Construction, Inc. for the Design, Fabrication and Erection of Structural Steel for Buildings; adopted June 1st, 1923, revised Nov. 1st, 1928.

Specification of the American Society for Testing Materials for Structural Steel for Buildings.

Code of Standard Practice of the American Institute of Steel Construction, Inc.; adopted Oct. 1st, 1924, revised 1927; 1928.

Specification of the American Institute of Steel Construction, Inc., for the Fireproofing of Structural Steel for Buildings; adopted Oct. 8th, 1927.

Recommendations of the United States Department of Commerce for the Minimum Allowable Live Loads for Buildings.

The History of Steel and Iron

In 1923 the American Institute of Steel Construction undertook the work of promoting uniform practice in the industry, and in order that its efforts would not be interpreted as being unduly influenced by commercial interests it selected a committee from among the leading talent in the academic, engineering and architectural professions to prepare a Standard Specification on the Design, Fabrication, and Erection of Structural Steel. This committee represented a combined experience of approximately one hundred and fifty years in an industry which is not more than thirty-five years old. The personnel was as follows:

GEORGE F. SWAIN:	M. Am Soc C E—M. Am Soc M E—M. Inst C E M. A R E A—Past President, A S C E—Professor of Civil Engineering, Harvard University
MILO S. KETCHUM:	M. Am Soc C E—M. A R E A—Dean of the College of Engineering, and Director of the Engineering Experiment Station of the University of Illinois
E. R. GRAHAM:	of Graham, Anderson, Probst & White, Architects, Chicago, Ill.
W. J. THOMAS:	M. Am Soc C E—Chief Engineer, Geo. B. Post & Sons, Architects, N. Y.
WILBUR J. WATSON:	M. Am Soc C E—M. A R E A—President, Watson Engineering Company, Cleveland, Ohio

STANDARD SPECIFICATION

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

Gentlemen:

After careful deliberation the Committee selected to prepare a Standard Specification for the design, fabrication and erection of structural steel for buildings, submit the accompanying Code for your adoption.

The present Specification contemplates that the inspection, is such that improper material containing defects which should cause rejection is not used. It is not intended to cover material salvaged from previous construction, which should not be used except under rigid supervision and inspection.

It is also understood that the proper loads are taken and that impact is allowed for in each case by adding a proper percentage to the stresses produced by static live loads so that the total stress found in any member is an equivalent static stress. This Specification does not attempt to state definitely what the live, dead, or wind loads should be, or what percentage should be added for impact, as these are factors which should receive the careful consideration of competent engineers for each case. The question of corrosion under unusual conditions should have careful consideration by the engineer.

The question of design is all-important. It necessarily presupposes that the design is good, made by and executed under the supervision of competent structural engineers; that proper provision is made for secondary stresses, excentric loads, unequal distribution of stresses on rivets, etc.; that the details are suitable and that the workmanship is high grade.

It is recommended that the American Institute of Steel Construction maintain a Committee whose function shall be that of keeping such a Code as we submit consistent with the changing conditions of manufacture, design, and erection. Under these conditions, the Committee considers the unit stresses herein specified are proper.

Respectfully submitted by the Committee:

GEORGE F. SWAIN
MILO S. KETCHUM
E. R. GRAHAM
W. J. THOMAS
WILBUR J. WATSON

June 1st 1923

STANDARD SPECIFICATION FOR STRUCTURAL STEEL FOR BUILDINGS

As adopted by the American Institute of Steel Construction

1. This Specification defines the practice adopted by the American Institute of Steel Construction for the design, fabrication, and erection of structural steel for buildings.

2. GENERAL

To obtain a satisfactory structure, the following major requirements must be fulfilled.

(a) The material used must be suitable, of uniform quality, and without defects affecting the strength or service of the structure.

(b) Proper loads and conditions must be assumed in the design.

(c) The unit stresses must be suitable for the material used.

(d) The workmanship must be good, so that defects or injuries are not produced in the manufacture.

(e) The computations and design must be properly made so that the unit stresses specified shall not be exceeded, and the structure and its details shall possess the requisite strength and rigidity.

3. MATERIAL

Structural steel shall conform to the Standard Specifications of the American Society for Testing Materials for Structural Steel for Buildings, Serial Designation A 9-21, as amended to date.

4. LOADING

(a) Steel structures shall be designed to sustain the dead weight imposed upon them, including the weight of the steel frame itself, and, in addition, the maximum live load as specified in each particular case. Proper provision shall be made for temporary stresses caused by erection.

(b) In cases where live loads have the effect of producing impact or vibration, a proper percentage shall be added to the static live load stresses to provide for such influences, so that the total stress found in any member is an equivalent static stress.

(c) Proper provision shall be made for stresses caused by wind both during erection and after completion of the building. The wind pressure is dependent upon the conditions of exposure, but the allowable stresses specified in section five (5), paragraphs (f) and (g), are based upon the steel frame being designed to carry a wind pressure of not less than twenty (20) pounds

per square foot on the vertical projection of exposed surfaces during erection, and fifteen (15) pounds per square foot on the vertical projection of the finished structure.

(d) Proper provision shall be made to securely fasten the reaction points of all steel construction and transmit the stresses to the foundations of the structure.

5. ALLOWABLE STRESSES

All parts of the structure shall be so proportioned that the sum of the maximum static stresses in pounds per sq. in. shall not exceed the following:

(a) *Tension.

Rolled Steel, on net section 18000

On the area of the nominal diameter of rivets under the limitations defined in Section 13, Paragraph **e** 13500

(b) Compression.

Rolled Steel, on short lengths or where lateral deflection is prevented . 18000

On gross section of columns,

$$\frac{18000}{1 + \frac{l^2}{18000\,r^2}}$$

with a maximum of 15000

in which l is the unsupported length of the column, and r is the corresponding least radius of gyration of the section, both in inches.

For main compression members, the ratio l/r shall not exceed 120, and for bracing and other secondary members, 200.

(c) Bending.

On extreme fibres of rolled shapes, and built up sections, net section, if lateral deflection is prevented 18000

When the unsupported length l exceeds 15 times b, the width of the compression flange, the stress in pounds per sq. in. in the latter shall not exceed

$$\frac{20000}{1 + \frac{l^2}{2000\,b^2}}$$

The laterally unsupported length of beams and girders shall not exceed 40 times b the width of the compression flange.

On extreme fibres of pins, when the forces are assumed as acting at the center of gravity of the pieces 27000

(d) Shearing.

On pins 13500

On power-driven rivets 13500

On turned bolts in reamed holes with a clearance of not more than 1/50 of an inch 13500

On hand-driven rivets 10000

On unfinished bolts 10000

*revised Nov. 1st, 1928.

On the gross area of the webs of beams and girders, where h, the height between flanges in inches, is not more than 60 times t, the thickness of the web in inches....................................12000

On the gross area of the webs of beams and girders if the web is not stiffened where h, the height between flanges in inches, is more than 60 times t, the thickness of the web, the maximum shear per square inch, $\frac{V}{A}$ shall not exceed

$$\frac{18000}{1 + \frac{h^2}{7200\,t^2}}$$

In Which V is the total shear, and A is gross area of web in square inches.

(e) **Bearing.**

	Double Shear	Single Shear
On pins	30000	24000
On power-driven rivets	30000	24000
On turned bolts in reamed holes	30000	24000
On hand-driven rivets	20000	16000
On unfinished bolts	20000	16000

On expansion rollers per lineal inch 600 times the diameter of the roller in inches.

(f) **Combined Stresses.** For combined stresses due to wind and other loads, the permissible working stress may be increased 33⅓%, provided the section thus found is not less than that required by the dead and live loads alone.

(g) **Members Carrying Wind Only.**
For members carrying wind stresses only, the permissible working stresses may be increased 33⅓%.

6. SYMMETRICAL MEMBERS.

Sections shall preferably be symmetrical.

7. BEAMS AND GIRDERS.

(a) Rolled beams shall be proportioned by the moment of inertia of their net section. Plate girders with webs fully spliced for tension and compression shall be so proportioned that the unit stress on the net section does not exceed the stresses specified in section five (5) as determined by the moment of inertia of the net section.

(b) Plate girder webs shall have a thickness of not less than 1-160 of the unsupported distance between the flanges.

(c) Web splices shall consist of a plate on each side of the web capable of transmitting the full stress through the splice rivets.

(d) **Stiffeners.** Stiffeners shall be required on the webs of rolled beams and plate girders at the ends and at points of concentrated loads, and at other points where h the clear distance between flanges is greater than $85t\sqrt{18000\ (A/V) - 1}$, in which t is the thickness of the web. When stiffeners are required, the distance in inches between them shall not be greater than $85t\sqrt{18000\ (A/V) - 1}$, or not greater than 6 feet. When h is greater than 60 times t the thickness of the web of a plate girder, stiffeners shall be required at distances not greater than 6 feet apart. Stiffeners under or over concentrated loads shall be proportioned to distribute such loads into the web.

Plate girder stiffeners shall generally be in pairs, one on each side of the web, and shall have a close bearing against the flange angles at points of concentrated loading; stiffeners over the end bearings shall be on plate fillers. The pitch of rivet in stiffeners shall not exceed 6″.

(e) **Flange plates** of all girders shall be limited in width so as not to extend more than 6″ or more than 12 times the thickness of thinnest plate beyond the outer row of rivets connecting them to the angles.

(f) **Crane runway girders** and the supporting framework shall be proportioned to resist the greatest horizontal stresses caused by the operation of the cranes.

(g) **Rivets** connecting the flanges to the web at points of direct load on the flange between stiffeners shall be proportioned to carry the resultant of the longitudinal and tranverse shears.

(h) **Rivets** connecting the flanges to the webs of plate girders and of columns subjected to bending shall be so spaced as to carry the increment of the flange stress between the rivets.

8. COLUMN BASES.

(a) Proper provision shall be made to distribute the column loads on the footings and foundations.

(b) The top surface of all column bases shall be planed for the column bearing.

(c) Column bases shall be set true and level, with full bearing on the masonry, and be properly secured to the footings.

9. EXCENTRIC LOADING.

Full provision shall be made for stresses caused by excentric loads.

10. COMBINED STRESSES.

(a) Members subject to both direct and bending stresses shall be so proportioned that the greatest combined stresses shall not exceed the allowed limits.

(b) All members and their connections which are subject to stresses of both tension and compression due to the action of live loads shall be designed

to sustain stress giving the largest section, with 50% of the smaller stress added to it. If the reversal of stress is due to the action of wind, the member shall be designed for the stress giving the largest section and the connections proportioned for the largest stress.

11. ABUTTING JOINTS.

Compression members when faced for bearings shall be spliced sufficiently to hold the connecting members accurately in place. Other joints in riveted work, whether in tension or compression, shall be fully spliced.

12. NET SECTIONS.

(a) In calculating tension members, the net section shall be used, and in deducting the rivet holes they shall be taken ⅛ inch greater in diameter than the nominal diameter of the rivets.

(b) Pin-connected tension members shall have the section through the pinhole 25% in excess of the net section of the member, and a net section back of the pin hole equal to 75% of that required through the pin hole.

13. RIVETS AND BOLTS.

(a) In proportioning rivets, the nominal diameter of the rivet shall be used.

(b) Rivets carrying calculated stresses, and whose grip exceeds five diameters, shall have their number increased 1% for each additional 1/10 inch in the rivet grip. Special care shall be used in heating and driving such rivets.

(c) Rivets shall be used for the connections of main members carrying live loads which produce impact, and for connections subject to reversal of stresses.

(d) Finished bolts in reamed holes may be used in shop or field work where it is impracticable to obtain satisfactory power-driven rivets. The finished shank shall be long enough to provide full bearing, and washers used under the nuts to give full grip when turned tight.

Unfinished bolts may be used in shop or field work for connections in small structures used for shelters, and for secondary members of all structures such as purlins, girts, door and window framing, alignment bracing and secondary beams in floor.

*(e) The end reaction stresses of trusses, girders, or beams, and the axial stresses of tension or compression members which are carried on rivets, shall have such stresses developed by the shearing and bearing values of the rivets; but where rivets are used for shelf or bracket supports or for connections that also provide rigidity to the structure, the rivets may in addition to their shearing and bearing stresses, carry tension as defined in Sec. 5 (a).

14. RIVET SPACING.

(a) The minimum distance between centers of rivet holes shall be three diameters of the rivet; but the distance shall preferably be not less than 4½

*revised Nov. 1st, 1928.

inches for 1¼ inch rivets, 4 inches for 1⅛ inch rivets, 3½ inches for 1 inch rivets, 3 inches for ⅞ inch rivets, 2½ inches for ¾ inch rivets, 2 inches for ⅝ inch rivets, and 1¾ inches for ½ inch rivets. The maximum pitch in the line of stress of compression members composed of plates and shapes shall not exceed 16 times the thinnest outside plate or shape, nor 20 times the thinnest enclosed plate or shape with a maximum of 12 inches, and at right angles to the direction of stress the distance between lines of rivets shall not exceed 30 times the thinnest plate or shape. For angles in built sections with two gage lines, with rivets staggered, the maximum pitch in the line of stress in each gage line shall not exceed 24 times the thinnest plate with a maximum of 18 inches.

(b) In tension members composed of two angles, a pitch of 3′-6″ will be allowed, and in compression members, 2′-0″, but the ratio l/r for each angle between rivets shall not be more than ¾ of that for the whole member.

(c) The pitch of rivets at the ends of built compression members shall not exceed four diameters of the rivets for a length equal to 1½ times the maximum width of the member.

(d) The minimum distance from the center of any rivet hole to a sheared edge shall be 2¼ inches for 1¼ inch rivets, 2 inches for 1⅛ inch rivets, 1¾ inches for 1 inch rivets, 1½ inches for ⅞ inch rivets, 1¼ inches for ¾ inch rivets, 1⅛ inches for ⅝ inch rivets, and 1 inch for ½ inch rivets. The maximum distance from any edge shall be 12 times the thickness of the plate, but shall not exceed 6 inches.

15. CONNECTIONS.

(a) Connections carrying calculated stresses except for lacing, sag bars, or angles, hand rails, or beam connections, shall not have less than 2 rivets; or for field connections not less than 3 rivets.

(b) Members meeting at a joint shall have their lines of center of gravity meet at a point if practicable; if not, provision shall be made for any excentricity.

(c) The rivets at the ends of any member transmitting the stresses into that member should have their centers of gravity in the line of the center of gravity of the member; if not, provision shall be made for the effect of the resulting excentricity. Pins may be so placed as to counteract the effect of bending due to dead load.

(d) When a beam or girder "A" is connected to another member in such a manner that "A" acts as a continuous or fixed end beam, proper provision shall be made for the bending moments at such a connection.

(e) Where stress is transmitted from one piece to another, through a loose filler, the number of rivets shall be properly increased; tight-fitting fillers shall be preferred.

16. LATTICE.

(a) The open sides of compression members shall be provided with lattice having tie plates at each end and at intermediate points if the lattice is

interrupted. Tie plates shall be as near the ends as practicable. In main members carrying calculated stresses the end tie plates shall have a length of not less than the distance between the lines of rivets connecting them to the flanges, and intermediate ones of not less than one-half of this distance. The thickness of tie plates shall not be less than one-fiftieth of the distance between the lines of rivets connecting them to the segments of the members, and the rivet pitch shall not be more than four diameters. Tie plates shall be sufficient in size and number to equalize the stress in the parts of the members.

(b) Lattice bars shall have neatly finished ends. The thickness of lattice bars shall be not less than one-fortieth for single lattice and one-sixtieth for double lattice of the distance between end rivets; their minimum width shall be as follows:

For 15″ channels, or built sections with 3½″ and 4″ angles—2¼″ (¾″ rivets), or 2½″ (⅞″ rivets).

For 12″, 10″, and 9″ channels, or built sections with 3″ angles—2¼″ (¾″ rivets).

For 8″ and 7″ channels, or built sections with 2½″ angles—2″ (⅝″ rivets), or 2¼″ (¾″ rivets)

For 6″ and 5″ channels, or built sections with 2″ angles—1½″ (½″ rivets), or 1¾″ (⅝″ rivets).

(c) The inclination of lattice bars to the axis of the members shall generally be not less than 45° but when the distance between the rivet lines in the flanges is more than 15 inches, the lattice shall be double and riveted at the intersection if bars are used, or else shall be made of angles.

(d) Lattice bars shall be so spaced that the ratio l/r of the flange included between their connections shall be not over ¾ of that of the member as a whole.

17. EXPANSION.

Proper provision shall be made for expansion and contraction.

18. MINIMUM THICKNESS.

No steel less than $\frac{5}{16}$ inch thick shall be used for exterior construction, nor less than ¼ inch for interior construction, except for linings or fillers and rolled structural shapes.

These provisions do not apply to light structures such as skylights, marquees, fire-escapes, light one-story buildings, or light miscellaneous steel work.

For trusses having end reactions of 35000 pounds or over, the Gusset Plates shall be not less than ⅜ inch thick.

19. ADJUSTABLE MEMBERS.

The initial stress in adjustable members shall be assumed as not less than 5000 lbs.

20. WORKMANSHIP.

(a) All workmanship shall be equal to the best practice in modern structural shops.

(b) Drifting to enlarge unfair holes shall not be permitted.

(c) The several pieces forming built sections shall be straight and fit close together; and finished members shall be free from twists, bends, or open joints.

(d) Rolled sections, except for minor details, shall not be heated.

(e) Wherever steel castings are used, they shall be properly annealed.

(f) **Punching.** Material may be punched $\frac{1}{16}$ inch larger than the nominal diameter of the rivets, whenever the thickness of the metal is equal to or less than the diameter of the rivets, plus ⅛ inch. When the metal is thicker than the diameter of the rivet, plus ⅛ inch, the holes shall be drilled, or sub-punched and reamed.

*(g) Rivets are to be driven hot, and wherever practicable, by power. Rivet heads shall be of hemispherical shape and uniform size throughout the work for the same size rivet, full, neatly finished, and concentric with the holes. Rivets, after driving, shall be tight, completely filling the holes, and with heads in full contact with the surface. Rivets shall be heated uniformly and their temperature before driving should not exceed 1950° F. which is a light yellow color. A gun should not be used for driving after the temperature is below 1000° F., which is a blood red color.

(h) Compression joints depending upon contact bearing shall have the bearing surfaces truly faced after the members are riveted. All other joints shall be cut or dressed true and straight, especially where exposed to view.

*(i) The use of a cutting torch is permissible if the metal being cut is not carrying stresses during the operation. Stresses shall not be transmitted through a flame cut surface. The radius of re-entrant flame cut fillets shall be as large as possible, but never less than 1″. To determine the net area of members so cut, ⅛″ shall be deducted from the flame cut edges.

21. PAINTING.

*(a) Parts not in contact, but inaccessible after assembling, shall be properly protected by paint. Surfaces to be riveted in contact shall not be painted.

(b) All steel work, except where encased in concrete, shall be thoroughly cleaned and given one coat of acceptable metal protection well worked into the joints and open spaces.

(c) Machine finished surfaces shall be protected against corrosion.

(d) Field painting is a phase of maintenance, but it is important that unless otherwise properly protected, all steel work shall after erection be protected by a field coat of good paint applied by a competent painter.

*revised Nov. 1st, 1928.

22. ERECTION.

(a) The frame of all steel skeleton buildings shall be carried up true and plumb, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment, and the operation of same. Such bracing shall be left in place as long as may be required for safety.

(b) As erection progresses the work shall be securely bolted up to take care of all dead load, wind and erection stresses.

(c) Wherever piles of material, erection equipment, or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from the same.

(d) No riveting shall be done until the structure has been properly aligned.

(e) Rivets driven in the field shall be heated and driven with the same care as those driven in the shop.

23. INSPECTION.

(a) Material and workmanship at all times shall be subject to the inspection of experienced engineers representing the purchaser.

(b) Material or workmanship not conforming to the provisions of this Specification shall be rejected at any time defects are found during the progress of the work.

(c) The Contractor furnishing such material or doing such work shall promptly replace the same.

(d) All inspection as far as possible shall be made at the place of manufacture, and the Contractor or Manufacturer shall co-operate with the Inspector, permitting access for inspection to all places where work is being done.

AMERICAN SOCIETY FOR TESTING MATERIALS

1315 Spruce Street, Philadelphia, Pa.

STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL FOR BUILDINGS

Serial Designation: A9-24

These specifications are issued under the fixed designation A 9; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

Adopted, 1901; Revised, 1909, 1913, 1914, 1916, 1921, 1924.

I. MANUFACTURE

Process

1. (**a**) Structural steel, except as noted in Paragraph (**b**), shall be made by either or both the following processes: Bessemer or open-hearth.

(**b**) Rivet steel, and steel for plates or angles over ¾ in. in thickness which are to be punched, shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS

Chemical Composition

2. The steel shall conform to the following requirements as to chemical composition:

		Structural Steel	Rivet Steel
Phosphorus	Bessemer	not over 0.10 per cent	
	Open-hearth	not over 0.06 per cent	not over 0.06 per cent
Sulfur			not over 0.045 per cent

Ladle Analyses

3. (**a**) A carbon determination shall be made of each melt of bessemer steel, and determinations for manganese, phosphorus and sulfur representing the average of the melts applied for each 12-hour period.

(**b**) An analysis of each melt of open-hearth steel shall be made for carbon, manganese, phosphorus and sulfur.

(**c**) These analyses shall be made by the manufacturer from test ingots taken during the pouring of each melt. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified in Section 2.

Check Analyses

4. Analyses may be made by the purchaser from finished material representing each melt. The phosphorus and sulfur content thus determined shall not exceed that specified in Section 2 by more than 25 per cent.

III. PHYSICAL PROPERTIES AND TESTS

Tension Tests

5. (**a**) The material shall conform to the following requirements as to tensile properties:

Properties Considered	Structural Steel	Rivet Steel
Tensile strength, lb. per sq. in. .	55,000—65,000	46,000—56,000
Yield point, min., per sq. in.	0.5 tens. str.	0.5 tens. str.
but in no case less than.	30,000	25,000
Elongation in 8 in., min., per cent.	$\frac{1,400,000}{\text{Tens. str.}}$	$\frac{1,400,000}{\text{Tens. str.}}$
Elongation in 2 in., min., per cent.	22	. . . .

[a] See Section 6.

(**b**) The yield point shall be determined by the drop of the beam of the testing machine.

Modifications in Elongation

6. (**a**) For structural steel over ¾ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in Section 5 (**a**) of 0.25 per cent shall be made for each increase of $\frac{1}{32}$ in. of the specified thickness above ¾ in., to a minimum of 18 per cent.

(**b**) For structural steel under $\frac{5}{16}$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in Section 5 (**a**) of 1.25 per cent shall be made for each decrease of $\frac{1}{32}$ in. of the specified thickness below $\frac{5}{16}$ in.

Bend Tests

7. (**a**) Bend test specimens, except as specified in Paragraph (**b**), shall stand being bent cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material ¾ in. or under in thickness, flat on itself; for material over ¾ in. to and including 1¼ in. in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1¼ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

(**b**) Bend test specimens for rivet steel shall stand being bent cold through 180 deg. flat on themselves without cracking on the outside of the bent portion.

Test Specimens

8. (**a**) Test specimens shall be prepared for testing from the material in its rolled or forged condition, except as specified in Paragraphs (**b**) and (**c**).

(**b**) Test specimens for annealed material shall be prepared from the material as annealed for use, or from a short length of a full section similarly treated.

(**c**) Test specimens for rivet bars which have been cold-drawn shall be normalized before testing.

(d) Test specimens shall be taken longitudinally and, except as specified in Paragraphs **(f)**, **(g)**, and **(h)**, shall be of the full thickness or section of material as rolled.

(e) Test specimens for plates, shapes and flats may be machined to the form and dimensions shown in Fig. 1, or with both edges parallel.

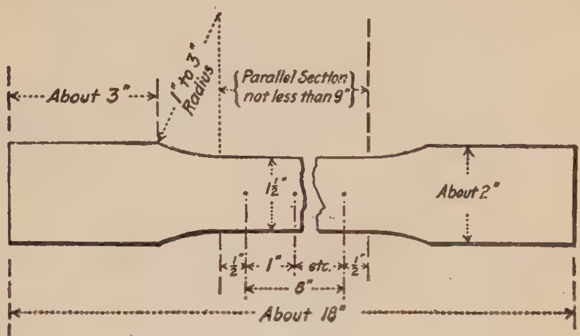
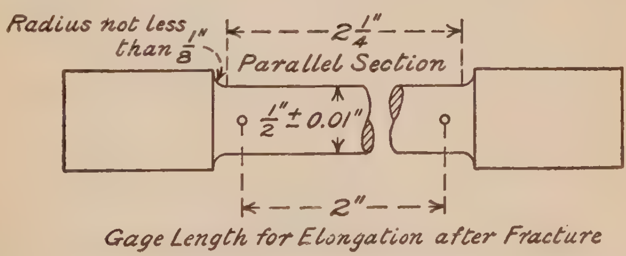


FIG 1.

(f) Tension test specimens for material over 1½ in. in thickness or diameter, except pins and rollers, may be machined to a thickness or diameter of at least ¾ in. for a length of at least 9 in., or they may conform to the dimensions shown in Fig. 2.



Note:-The Gage Length, Parallel Section, and Fillets shall be as Shown, but the Ends may be of any Shape to fit the Holders of the Testing Machine in such a Way that the Load shall be axial.

FIG. 2.

(g) Bend test specimens for material over 1½ in. in thickness or diameter, except pins and rollers, may be machined to a thickness or diameter of at least ¾ in. or to 1 by ½ in. in section.

(h) Tension test specimens for pins and rollers shall conform to the dimensions shown in Fig. 2, and bend test specimens shall be 1 by ½ in. in section.

(i) Test specimens for pins and rollers shall be taken so that the axis is 1 in. from the surface.

(j) The machined sides of rectangular bend test specimens may have the corners rounded to a radius not over $\frac{1}{16}$ in.

Number of Tests

9. (**a**) One tension and one bend test shall be made from each melt; except that if material from one melt differs ⅜ in. or more in thickness, one tension and one bend test shall be made from both the thickest and the thinnest material rolled.

(**b**) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(**c**) If the percentage of elongation of any tension test specimen is less than that specified in Section 5 (**a**) and any part of the fracture is more than ¾ in. from the center of the gage length of a 2-in. specimen or is outside the middle third of the gage length of an 8-in. specimen, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS

Permissible Variations

10. (**a**) The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent from that specified; except in the case of sheared plates, which shall be covered by the permissible variations specified in Paragraphs (**b**) and (**c**). (One cubic inch of rolled steel is assumed to weigh 0.2833 lb.)

(**b**) **Sheared Plates, When Ordered to Weight per Square Foot:** The weight of each lot[1] in each shipment shall not vary from the weight ordered more than the amount given in Table I.

(**c**) **Sheared Plates, When Ordered to Thickness:** The thickness of each plate shall not vary more than 0.01 in. under that ordered.

The overweight of each lot[1] in each shipment shall not exceed the amount given in Table II.

V. FINISH

Finish

11. The finished material shall be free from injurious defects and shall have a workmanlike finish.

VI. MARKING

Marking

12. The name or brand of the manufacturer and the melt number shall be legibly stamped or rolled on all finished material, except that rivet and lattice bars and other small sections shall, when loaded for shipment, be properly separated and marked for identification. The identification marks shall be legibly stamped on the end of each pin and roller. The melt number shall be legibly marked, by stamping if practicable, on each test specimen.

[1] The term "lot" as applied to Table I means all of the plates of each group width and group weight; as applied to Table II, it means all of the plates of each group width and group thickness.

VII. INSPECTION AND REJECTION

Inspection

13. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection

14. (**a**) Unless otherwise specified, any rejection based on tests made in accordance with Section 4 shall be reported within five working days from the receipt of samples.

(**b**) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing

15. Samples tested in accordance with Section 4, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

Table I.—Permissible Variations of Rectangular Plates Ordered to Weight.

Ordered Weight, Lb. per Sq. Ft.	Permissible Variations in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Ordered Weights																		Ordered Weight, Lb. per Sq. Ft.
	Under 48 in.,		48 to 60 in., excl.		60 to 72 in., excl.		72 to 84 in., excl.		84 to 96 in., excl.		96 to 108 in., excl.		108 to 120 in., excl.		120 to 132 in., excl.		132 in. or over		
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	
Under 5	5	3	5.5	3	6	3	7	3	....	....	....	....	....	....	....	....	....	....	Under 5
5 to 7.5 excl.	4.5	3	5	3	5.5	3	6	3	....	....	....	....	....	....	....	....	....	....	5 to 7.5 excl.
7.5 to 10 "	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	....	....	....	....	7.5 to 10 "
10 to 12.5 "	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	9	3	10 to 12.5 "
12.5 to 15 "	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	12.5 to 15 "
15 to 17.5 "	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	15 to 17.5 "
17.5 to 20 "	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	17.5 to 20 "
20 to 25 "	2	2	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	20 to 25 "
25 to 30 "	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	5	3	25 to 30 "
30 to 40 "	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	30 to 40 "
40 or over	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	40 or over

Note.—The weight per square foot of individual plates shall not vary from the ordered weight by more than 1⅓ times the amount given in this table.

Table II.—Permissible Overweights of Rectangular Plates Ordered to Thickness

Ordered Thickness, In.	Permissible Excess in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Nominal Weights									Ordered Thickness, In.
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in. or over	
Under $\frac{1}{8}$	9	10	12	14	....	....	....	....	....	Under $\frac{1}{8}$
$\frac{1}{8}$ to $\frac{3}{16}$ excl.	8	9	10	12	....	....	....	....	....	$\frac{1}{8}$ to $\frac{3}{16}$ excl.
$\frac{3}{16}$ to $\frac{1}{4}$ "	7	8	9	10	12	....	....	....	....	$\frac{3}{16}$ to $\frac{1}{4}$ "
$\frac{1}{4}$ to $\frac{5}{16}$ "	6	7	8	9	10	12	14	16	19	$\frac{1}{4}$ to $\frac{5}{16}$ "
$\frac{5}{16}$ to $\frac{3}{8}$ "	5	6	7	8	9	10	12	14	17	$\frac{5}{16}$ to $\frac{3}{8}$ "
$\frac{3}{8}$ to $\frac{7}{16}$ "	4.5	5	6	7	8	9	10	12	15	$\frac{3}{8}$ to $\frac{7}{16}$ "
$\frac{7}{16}$ to $\frac{1}{2}$ "	4	4.5	5	6	7	8	9	10	13	$\frac{7}{16}$ to $\frac{1}{2}$ "
$\frac{1}{2}$ to $\frac{5}{8}$ "	3.5	4	4.5	5	6	7	8	9	11	$\frac{1}{2}$ to $\frac{5}{8}$ "
$\frac{5}{8}$ to $\frac{3}{4}$ "	3	3.5	4	4.5	5	6	7	8	9	$\frac{5}{8}$ to $\frac{3}{4}$ "
$\frac{3}{4}$ to 1 "	2.5	3	3.5	4	4.5	5	6	7	8	$\frac{3}{4}$ to 1 "
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

CODE OF STANDARD PRACTICE

PREFACE

Since the use of structural steel came into existence about 1890, there has developed an industry engaged in the fabrication and erection of this material. At the present time this industry is furnishing annually over $300,000,000 worth of material to the public.

During this period of evolution it is obvious that many inconsistent practices should have come into existence, and the American Institue of Steel Construction, representing the industry between the rolling mills and the buying public, have undertaken the codifying of the various conditions, with a view of establishing uniform practice.

The Institute's Specification on the design, fabrication, and erection of structural steel has been received with wide spread approval, and this Code of Standard Practice is now being issued to cover conditions not touched in the Specification.

CODE OF STANDARD PRACTICE

As adopted by the
American Institute of Steel Construction, Inc.

SECTION 1. GENERAL

(a) Scope.

The rules and practices hereinafter defined are adopted by the American Institute of Steel Constuction as standard for the industry and shall govern all conditions where the contract between the buyer and seller does not specify otherwise and where they do not conflict with local or state requirements.

(b) Design.

Unless otherwise specified or required, the design, fabrication and erection of structural steel shall conform to the Standard Specification of the American Institute of Steel Construction for buildings, dated June 1, 1923, or as amended to date.

(c) Plans and Specifications for bidding.

The plans shall show a complete design with sizes, sections and the relative location of various members with floor levels, column centers and offsets figured, and shall show the character of the work to be performed with sufficient dimensions to permit the making of an accurate estimate of cost. Plans shall be made to scale not less than 1/8" to the foot, and large enough to convey the information adequately.

Wind bracing and special details when required shall be shown in sufficient detail regarding rivets and construction to permit an accurate estimate of cost.

(d) Responsibility of Design and Erection.

If the design, plans and specifications are prepared by the Buyer, the Seller shall not be responsible for the suitability, strength, rigidity or the practicability of erection.

SECTION 2. CLASSIFICATION

The Steel and iron items entering into the construction of a structure are divided into the following classes:

CLASS "A"—Structural Steel and Iron
CLASS "B"—Ornamental Steel and Iron
CLASS "C"—Steel Floor Joists
CLASS "D"—Miscellaneous Steel and Iron

In contracting to furnish the material for a structure where the material to be furnished is designated as structural steel and iron, ornamental steel and iron, steel floor joists, or miscellaneous steel and iron, the Seller will furnish only such items under each classification as are listed below, and no other items will be included unless by special agreement. In cases where materials in excess of minimum requirements are furnished to provide for waste or loss, all unused material remaining after completion of work shall be the property of the Seller and returned to him.

Unless specifically agreed to in the contract, the Seller of the structural steel "Class A" will not provide field connections or field holes for the ornamental steel and iron "Class B," the miscellaneous steel and iron "Class D," nor the materials for any other trades.

(a) Class "A" Structural Steel and Iron.

Contracts taken to furnish the structural steel and iron for a building are based on furnishing the following items only:

Anchors for structural steel only
Bases of steel or iron only
Beams of rolled structural steel
Bearing plates for structural steel
Brackets made of structural steel shapes
Channels of rolled structural steel
Channels and angle supports only for suspended ceilings where they attach to structural steel, but not including small channel or angle furring
Columns, structural steel, cast iron and pipe
Girders of structural steel
Grillage beams and girders—structural steel
Hangers of structural steel
Lintels as shown or enumerated
Marquise (structural frame only)
Rivets and bolts for field connections, as follows:

1. The Seller shall furnish sufficient rivets of suitable size, plus at least 10% to cover waste for all field connections of steel to steel which are designated as riveted field connections.
2. The Seller shall furnish sufficient bolts of suitable size, plus 5% to cover waste for all field connections of steel to steel which are designated to be bolted.
3. No fitting up bolts or washers will be included unless specifically called for.

Separators, angles, tees, clips, bracing and detail fittings in connection with structural steel frame
Tie rods
Trusses of structural steel

(b) Class "B" Ornamental Steel and Iron.

Contracts taken to furnish the ornamental steel and iron for a building are based on furnishing the following items only:

All bronze and brass work, except hardware fittings
Balconies
Cast iron cornices
Curtain guides
Elevator fronts and enclosures
Grilles and gratings
Iron store fronts
Lamp standards and brackets
Marquise (steel or iron, except frame) see Class "A"

Ornamental brackets, steel or iron
Ornamental inside stairs, steel or iron
Ornamental outside steel or iron stairs, including fire escapes
Safety treads
Railings (gas pipe, ornamental or brass)
Sills and thresholds (brass, steel or iron)
Spiral stairs, steel or iron
Window sills and frames, steel or iron
Wire work, ornamental steel or iron

(c) **Class "C" Steel Floor Joists.**

Contracts taken to furnish the steel floor joists for a building are based on furnishing the following items only:

Steel joists which are not a part of the structural steel frame for the building, and which are devised to carry the floor or roof panels.
Bracing and bridging for floor joists; clips for fastening floor joists
Stirrup and hanger for floor joists
Ties for floor joists

(d) **Class "D" Miscellaneous Steel and Iron.**

The nature and character of the material of this classification makes it impossible to cover all items and it is recommended that the Seller taking the contract to furnish the miscellaneous steel and iron work for a building specify all items in detail which it is intended to furnish. The general list of items under this classification is as follows:

Area gratings
Cast iron cover and frames
Cast iron rainwater receivers
Cast iron downspout shoes
Cleanouts
Coal chutes
Column guards
Door frames and bucks
Foot scrapers
Furnace or fireplace dampers
Flag pole
Ladders
Pin rails
Sidewalk doors
Sills and curb angles, and anchors for same
Special bolts or anchors where distinctly shown on the plans
Stairs made of plain structural steel—not including treads of other materials
Stacks
Steel and cast iron platforms
Steel or iron chimney caps
Thimbles
Wall plate anchors

Wheel guards
Window guards
Wire screens for partitions, door and window guards (this does not include fly screens)

(e) **Materials not classed under above headings.**

The following items are not covered by classifications A-B-C and D and will in no case be furnished by the Seller unless specifically agreed to and mentioned in the contract. It is not possible to designate every detail and the list is typical of material not included in classifications A-B-C and D. It is shown here to assist the Architect and Engineer in avoiding confusion.

Ash hoists
Awning boxes
Boilers
Elevators or accessories
Elevator guides or sheave beams
Expanded metal
Furring
Glass for any purpose whatever
Hollow metal doors or frames
Hoppers
Mail chute
Metal lockers
Miscellaneous carpenter or masonry bolts for connecting wood to wood steel to wood, or wood to stone, etc.
Name plates
Patented devices
Pilot and driving nuts
Reinforcing steel
Rolling doors
Sheet metal work or corrugated sidings and roofing
Sidewalk lights
Steel sash and steel sash partitions
Spiral slides
Suspended ceiling, except as noted under Class "A"
Tanks and pans
Toilet partitions
Treads, except steel or iron
Vault doors
Ventilating brick
Wall, ceiling and floor registers
Wood handrails
Wood handrail brackets
And all other material not mentioned

SECTION 3. INVOICING

When conditions make it possible to award contracts on a lump sum basis the confusion of determining weights will be avoided. Scale weights involve a variation which frequently lead to a compromise based on calculated weights.

The rules hereinafter established, while not giving exact weights, are the basis upon which the Seller must make a lump sum or a pound price bid and they eliminate the necessity of increased cost of shop drawings and other refinements of manufacture which would very materially increase costs if exact weights were required.

(a) Weights.

Structural steel and iron sold at a unit price per pound, hundred weight (100 #) or ton (2000 #) shall be invoiced on the calculated weights of shapes, plates, bars, castings, rivets and bolts, based on the detailed shop drawings and shop bills of material which show actual dimensions of materials used as follows:

Dimensions:—

The weight will be figured on the basis of rectangular dimensions for all plates, and ordered overall lengths for all structural shapes and with no deductions for copes, clips, sheared edges, punchings, borings, milling or planing. When parts can be economically cut in multiples from material of larger dimension, the calculated weight shall be taken as that of the material from which the parts are cut.

Over-run, as follows:—

1. To the nominal theoretical weight of all universal mill and sheared plates or slabs will be added one-half the allowance for variation or over-weight in accordance with the specifications of the American Society for Testing Materials. All plates less than 5 feet in length shall be subject to the variation or over-weight given for sheared plates. (See table in A. S. T. M. Specification).
2. Reinforcing bars when not sold on a basis of scale weights shall be invoiced by the Seller at the theoretical weights plus 1½% to allow for over-run weight of deformations, etc.
3. The calculated weights of castings shall be the weights determined from the detail drawings of the pieces including standard fillets for such pieces. To this an average over-run of 10% shall be added.

Rivets, as follows:—

1. The weight of shop rivets will be based on the weights shown in the following table:

Rivets	½″	in diameter 20	# per 100 rivets
Rivets	⅝″	in diameter 30	# per 100 rivets
Rivets	¾″	in diameter 50	# per 100 rivets
Rivets	⅞″	in diameter 100	# per 100 rivets
Rivets	1″	in diameter 150	# per 100 rivets
Rivets	1⅛″	in diameter 250	# per 100 rivets
Rivets	1¼″	in diameter 325	# per 100 rivets

2. Field rivets and bolts shall be invoiced at their actual weight.

Paint:—

One-half of 1% of the theoretical weights of the material painted will be added for each coat of paint. For work oiled, one-fourth of 1% for each coat will be added.

SECTION 4. DRAWINGS AND SPECIFICATIONS

(a) The Buyer shall furnish the Seller within a time agreed to in the contract a survey of the lot lines, together with a complete and full design of the structural steel frame definitely locating all openings, levels, etc.; and showing all material to be furnished by the Seller with such information as may be necessary for the completion of the shop drawings by the Seller. All such information and drawings shall be consistent with the original drawings and specifications.

(b) In case of discrepancies between the drawings and the specifications prepared by either the Seller or the Buyer, the specification shall govern; and in case of discrepancies between the scaled dimensions on the drawings and the figures written on them, the figures shall govern.

Should the Seller in the execution of his work find discrepancies in the information furnished by the Buyer, he shall refer such discrepancies to the Buyer before proceeding further with work which would be affected.

(c) Shop Drawings shall be made and submitted to the representative of the Buyer, who shall examine the same and return them approved with such corrections as he finds necessary. They shall be corrected by the Seller if necessary and returned for the Buyer's file as finally approved. The Seller may proceed with shop work, but in so doing he shall assume responsibility for having properly made the corrections indicated by the Buyer.

In addition to the set of blue prints of approved shop drawings for the Buyer's file as above referred to, the Buyer may require the Seller to furnish without cost to the Buyer, one additional set of shop drawing blue prints, but any further additional sets shall be paid for by the Buyer at cost, plus overhead and a fixed per cent for profit. All drawings or tracings made by the Seller for the execution of his work shall remain his property unless otherwise specifically agreed to.

(d) Shop Drawings prepared by the Seller and approved by a representative of the Buyer shall be deemed the correct interpretation of the work to be done, but does not relieve the Seller of responsibility for the accuracy of details.

(e) After the plans and shop drawings have been "approved" or "approved as noted" by the authority designated in the contract, any further changes required shall be made at the expense of the Buyer.

(f) When detailed shop drawings are furnished by the Buyer no responsibility for misfits due to errors in the drawings will be assumed by the Seller.

SECTION 5. GOOD WORKMANSHIP AND STANDARD PRACTICE

Good workmanship and standard practice in a modern structural shop is defined as follows:

(a) Material.

Stock material shall be of a quality substantially equal to that called for by the specifications of the American Society for Testing Materials for the classifications covering its intended use; and mill test reports shall constitute sufficient record as to the quality of material carried in stock. It is obviously

impossible for the Seller to maintain records of heat or blow numbers of every piece of material in his stock, and the same shall not be required if all his stock purchases are made under an established specification as to grade and quality.

Whenever a shop maintains such a practice in carrying a stock of material, it is deemed good practice to permit the use of such stock material in its fabricating operations whenever the shop desires to do so, instead of ordering items from the mill for a specific operation. Stock materials bought under no particular specifications, or under specifications materially less rigid than those mentioned above, or stock material which has not been subject to mill or other recognized test reports, shall not be used, except as noted below, without the approval of the Buyer and under rigid inspection.

It is permitted to use unidentified stock material free from surface imperfections for short sections of minor importance or for small unimportant details, where the quality of the material could not affect the strength of the structure.

(b) Straightening and Cleaning.

All material shall be clean and straight, and if straightening or flattening is necessary, it shall be done by a process that will not injure the material. Sharp kinks or bends shall be cause for rejection.

(c) Punching.

The punch shall be $\frac{1}{16}''$ larger than the nominal diameter of the rivet, and the die opening not more than $\frac{1}{8}''$ larger than the diameter of the punch. The thickness of the material in punched work shall not be greater than nominal diameter of the rivet, plus $\frac{1}{8}''$. The accuracy of the punching shall be such that for any group of holes when assembled, 75% shall admit a rod equal to the diameter of the cold rivet at right angles to the plane of the connection, otherwise the holes shall be reamed.

Likewise, when work is assembled, all holes which will not admit a rod $\frac{1}{8}''$ smaller than the nominal diameter of the cold rivet shall be reamed.

(d) Reaming.

Reamed or drilled holes shall not be required unless specifically agreed to in the contract. When specifications require that work shall be sub-punched and reamed the die used for punching shall be $\frac{1}{16}''$ smaller than the nominal diameter of the rivet, and the assembled holes shall be reamed to a diameter of $\frac{1}{16}''$ larger than the nominal diameter of the rivet.

(e) Planing.

Planing or finishing of sheared plates or shapes will not be required unless specifically called for by the specifications or drawings.

(f) Assembling.

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting done during assembling shall not distort the metal to enlarge the hole on the side on which the die was used in punching.

Finished members shall be true to line and free from twists, bends and open joints. It is not the function of fitting up bolts to bring improperly straightened material into place, thus causing a strain on the rivets in the finished work.

Compression members shall not have a lateral variation greater than 1 to 1000 of the axial length between the points which are to be laterally supported.

An allowable variation of $\frac{1}{32}''$ is permissible in the over all length of members with both ends milled.

Members without milled ends which are to be assembled to other steel parts of the structure shall not have an error greater than $\frac{1}{16}''$ for members 30 feet or less in length, and not more than $\frac{1}{8}''$ for members over 30 feet in length.

(g) *Riveting.

Rivets shall be heated uniformly and their temperature before driving should not exceed 1950° F. which is a light yellow color. A gun should not be used for driving after the temperature is below 1000° F., which is a blood red color. Rivets shall be driven and the heads formed with a proper sized die while hot. When heated and ready for driving, rivets shall be free from slag scale and carbon deposits. When driven they shall completely fill the holes.

Loose, burned or otherwise defective rivets shall be replaced. After driving, the rivet heads shall be full, neatly made, concentric with the rivet hole, and in full contact with the surface of the member. Caulking the rivet head shall not be permitted.

***(h) Cutting Torch.**

The use of a cutting torch is permissible if the metal being cut is not carrying stresses during the operation. Stresses shall not be transmitted through a flame cut surface. The radius of re-entrant flame cut fillets shall be as large as possible, but never less than 1″. To determine the net area of members so cut, $\frac{1}{8}''$ shall be deducted from the flame cut edges.

SECTION 6. INSPECTION AND DELIVERY

(a) Inspection.

The Seller's shop service includes inspection by his own inspectors, and shop or mill inspection other than this shall be paid for by the Buyer.

(b) Acceptance of Materials.

When material is inspected by a representative of the Buyer at the Shop, the acceptance of such material by the Buyer's representative shall be considered the Buyer's final approval; but the Seller shall be responsible for the accuracy of the work and for defective material or workmanship which may be discovered before the completion of the structure.

(c) Order of Delivery.

Unless the order or sequence of delivery is specifically arranged for before the work is undertaken, it will be at the convenience of the Seller.

(d) Materials sold delivered.

When material is sold delivered on cars or trucks at the site of the structure, all unloading shall be done by the Buyer, and all responsibility to persons or property during such unloading shall be at the Buyer's risk.

*Revised 1928.

(e) **Loss in shipment where material is sold fabricated only.**

The quantity of material shown by the shipping statement will in all cases govern settlements unless notice of shortage is immediately reported to the agent of the delivering carrier, and his signed verification obtained, and like notice sent to the Seller within 48 hours after receipt of the shipment, in order that the alleged shortage may be investigated by the Seller.

(f) **Storage of Material.**

Where conditions make it necessary that material be stored for any length of time, and the contract does not provide for such storage, payments are to come due and be payable the same as if the material had been delivered at the building site; and the Seller shall be compensated for handling, storage, and other increased expenses that may result from such conditions.

SECTION 7. ERECTION

(a) **Foundations.**

The Seller or erector shall not be responsible for the strength or suitability of the foundations.

(b) **Building Lines and Bench Marks.**

Building lines and bench marks at the site of the structure shall be accurately located by the Buyer, and carefully shown or described by him or his representative to the steel erector or his engineer.

(c) **Steel and Cast Iron Bases.**

All steel grillage, steel slabs, cast iron, or steel bases, or steel columns with bases fabricated as an integral part of the column shall be set and wedged or shimmed by the seller or steel erector to grade or level lines, which are determined and fixed by the buyer, who shall grout all such parts in place. Before grouting the buyer shall check the grades and levels of the parts to be grouted, and shall be responsible for the accuracy of the same.

(d) **Anchor Bolts.**

All anchor or foundation bolts shall be set by the Buyer.

(e) **Working Room.**

The erection contractor shall be entitled to sufficient space at the site of the structure at a place convenient to him to place his derricks and other equipment necessary for erection. When conditions at the site provide working space not occupied by the structure, the erection contractor shall be entitled to storage space for sufficient material to keep his working force in continuous operation.

(f) **Plumbing Up.**

The temproary guys and braces shall be the property of the Seller, and if after the steel has been plumbed and leveled, the work of completing the structure by other contractors is suspended or delayed the owner of the temporary guys and braces shall receive reasonable compensation for their use. The guys shall be removed by the Buyer at his expense, and returned to the Seller in as good condition as when placed in the building with a reasonable depreciation.

Immediately upon completion by the steel erector, the Buyer shall assure himself by whatever agencies he may elect, that the steel erector's work is plumb and level, and properly guyed. If it is not, he should immediately notify the erector and direct him to perfect his work. After the steel erector has guyed and plumbed the work once to the satisfaction of the Buyer, his responsibility ceases. Any further work in guying or plumbing shall be performed entirely at the Buyer's expense.

In the setting or erecting of structural steel work, the individual pieces shall be considered plumb or level where the error does not exceed 1 to 500.

For exterior columns and columns adjacent to elevator shafts of multiple story buildings, the error from plumb shall not exceed 1 to 1000 for the total height of the column.

(g) **Opportunity to Investigate Errors.**

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered as a legitimate part of erection. Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins, or a moderate amount of reaming and slight chipping or cutting, shall immediately be reported to the Seller and his approval of the method of correction obtained.

(h) **Wall Plates.**

All loose masonry bearing plates for beams, lintels, trusses or columns shall be set and grouted to grade and line by the Buyer ready for the steel erector to set his work.

(i) **Loose Lintels.**

Loose lintels or pieces of all kinds and descriptions required by the design of a building to carry brick work over openings, and which lintels or pieces are not attached in any way to the rest of the steel structure, and cannot be placed except as the masonry work advances, will not be erected by the steel erector unless by special agreement.

(j) **Ornamental Iron and Bronze.**

Fine ornamental iron and bronze work is considered as finishing material, and shall not be set in a building until after the marble, plaster, and other work, except decorating, is in place.

(k) **Elevator Framing.**

The setting or erection of guides, cars, machinery, cables, sheaves, pans, etc., for elevators, is not to be required of the steel erector.

(l) **Field Assembling.**

The size of assembled pieces of structural steel is fixed by the permissible weight and clearance dimensions of transportation. Unless such conditions are provided for by the Buyer or his engineer, the Seller shall provide for such field connections as will require the least field work; and such field connections shall be a part of the erection work.

(m) **Cutting and Patching.**

The Seller shall not be required to cut or patch any work, except his own,

unless particularly specified, and will not alter his own work required by changes or inaccuracies in the building without being reimbursed for the expense of such changes.

(n) Insurance.

The erector shall indemnify and save harmless the Buyer from all claims and costs arising from any damages to person or property occurring in the performance of his work due to any act or neglect of his employees or agents.

(o) Temporary Floors.

The Buyer shall provide plank, and cover all floors required by municipal or state laws, excepting the floor upon which the erecting derricks are located. This floor will be covered by the steel erector for working purposes.

(p) Field Paint.

Unless specifically agreed to in the contract, field paint shall be considered a phase of maintenance, and such protection as is necessary shall be provided for by the Buyer.

SECTION 8. DELAYS IN PROSECUTION OF WORK

(a) Causes not controlled by Seller or Buyer.

Neither Seller nor Buyer shall be responsible for delays in performance caused by delays at rolling mills, or in transportation, or due to strikes, fires, floods, storms, or other circumstances beyond their reasonable control whether related or unrelated, or similar or dissimilar to any of the foregoing. In case of delay to work due to any of the above causes, a reasonable extension of time shall be given for the completion of the work.

(b) Delays caused by the Seller.

Should the Seller at any time, except as provided in the preceding paragraphs, refuse or neglect to supply enough workmen of proper skill or material of proper quality, or to carry on the work with promptness and diligence, the Buyer, if not in default, may give the Seller ten days written notice, and at the end of that time if the Seller continues to neglect the work, the Buyer may provide such labor or materials and deduct the cost from any money due or to become due the Seller under the contract, or may terminate the employment of the Seller under the agreement and take possession of the premises and of all materials, tools, and appliances thereon and employ any other person to finish the work. In the latter case, the Seller shall receive no further payment until the work be finished; then if the unpaid balance that would be due under the contract exceeds the cost to the Buyer of finishing the work, such excess shall be paid to the Seller; but if such cost exceeds unpaid balance, the Seller shall pay the excess to the Buyer.

(c) Delays caused by the Buyer.

The Buyer shall be responsible for delays resulting from lack of complete data and from changes or revisions or the tardy approval of drawings. Information given later than the date fixed in the contract for the delivery of complete

information shall not be cause for a claim by the Seller unless such delay affects Seller's costs or manufacturing operations. When such delays increase costs or compel changes in the Seller's manufacturing operations he shall be recompensed for the damage resulting.

If information is available for the Seller to manufacture or erect the material in accordance with the conditions of the contract, and if he is prevented from the orderly and continuous prosecution of such work by any act or a neglect of the Buyer, the Seller may continue his work and may place fabricated material in storage at his own plant or elsewhere and the Buyer shall, upon tender of transfer of title, pay for said material as if it had been delivered under the terms of the contract. The Buyer shall also recompense the Seller for all expense incurred in the storing, caring for, or re-handling of said material; and for damage resulting from changed manufacturing operations. On erection work the Seller shall be recompensed for any extra expense incurred in wages and in the transportation of men or equipment to and from the site and their maintenance at the site during the period of delay, also for extra expense resulting from overtime made necessary by such delay.

If for more than one month at any time, any act or neglect of the Buyer, or any legal proceeding taken against him, prevents the starting or continuous prosecution of the work, the Seller may give the Buyer ten days written notice, and at the end of that time, if the Buyer continues at fault or the legal proceeding continues effective, the Seller may terminate his obligations under the contract; in which case the Buyer shall at once pay the Seller for the work done and material provided, and all damages the Seller may sustain, including damages resulting from changed shop operations.

SECTION 9. EXTRA WORK

(a) General.

Charges for extra work, or work not covered by the contract, shall be made on a basis that is definitely and mutually understood between the Buyer and the Seller at the time the occasion for such extra expense arises.

In the absence of such an understanding between the Buyer and Seller, the following is listed as proper expenses.

(b) Material.

All extra material required shall be invoiced out at current warehouse prices, plus cost of fabrication, including regular overhead costs, plus transportation costs, and an agreed per cent for profit.

(c) Drafting Labor.

All extra labor in the drafting room shall be invoiced out at cost plus overhead, plus an agreed per cent for profit.

(d) Shop Work.

All extra shop labor shall be charged at actual cost as shown by the time cards; to this shall be added the overhead expense, and the use of equipment and power. The sum of these charges shall be considered the actual cost of the shop, to which shall be added an agreed per cent for profit.

(e) **Field Work.**

All extra labor required in the erection of structural steel shall be invoiced as follows:

The actual labor cost shall be that shown by the time cards, to which shall be added the actual cost of insurance, the cost of labor transportation when necessary, and an additional allowance for overhead expense. The sum of these shall be considered the actual cost, to which shall be added an agreed per cent of profit.

Should the buyer or his agent or other trades engaged in the erection of other work connected with the structure require the use of materials or equipment belonging to the Seller, the Seller shall receive compensation for such extra service together with depreciation of equipment and an agreed per cent for profit.

(f) **Miscellaneous.**

Any additional cost, such as hauling, painting, crating, freight, etc., shall be charged at actual cost, plus overhead, plus insurance, plus an agreed per cent for profit.

(g) **Overtime.**

On contract work where the Seller has not agreed to work overtime, he shall not be required to do so without being paid for his extra expense and a profit.

(h) **Extra Cleaning.**

If because of continued storage, or for any other reason not the fault of the Seller, it should be necessary to clean and repaint the steel work, the cost of this additional cleaning and painting should be paid for as an extra, including regular overhead charges as specified for extra work elsewhere in this section.

SECTION 10. PROPOSALS AND CONTRACTS

(a) **Direct Contracts.**

It is recommended that in all cases where the structural steel frame of a building is self supporting, and also in all such other cases where the structural steel and iron items entering into the construction of a building can easily be separated from the other materials of construction, that all contracts for such structural steel or iron be made separately by the owner or his representative with the steel contractor.

(b) **Conflicts.**

In the event of a conflict between the terms and conditions of the proposal, and the terms and conditions stated in the plans and specifications, the terms of the proposal shall govern.

(c) **Price for additions or deductions.**

The Seller is not to be required nor expected to make the same unit price for additions to as for deductions from the list of material required for a structure. The contract, may however, specify a certain other unit price for such materials as may be deducted from the quantity of material as originally contemplated by the contract.

(d) Material not shown or called for.

Clauses in the specification to the effect that all steel and iron items necessary to complete the structure shall be furnished by the Seller, whether or not they are shown on the plans or called for in the specifications, being obviously unfair, will not be recognized or subscribed to. The Seller shall, however, furnish all material and labor for details that may be required for such steel and iron work as is shown on the drawings or called for in the specification, although such details may themselves not be shown or called for.

(e) Items not to be furnished.

Unless specifically mentioned in the request for bids, or specifically agreed to, the bidders do not estimate or include the following items in their proposals:

Any charges for surety bonds or insurance not required by law, or any other general charge such as building permits, license fees or taxes for permission to work in city or state, engineering fees, removal of rubbish, patching or repairing of plaster or masonry work, office or telephone service, light, heat, fire insurance, or the erection of temporary structures, enclosures or stairs.

(f) Terms.

The following terms of payment are adopted as standard and will govern in all cases, except when otherwise agreed to in the contract.

1. All payments shall be made in funds current at par in the city in which the Seller furnishing the material is located.

2. All materials for export, net cash in exchange for shipping documents will be required.

3. For all materials to be erected by the Seller, the Buyer shall on the 10th day of each month pay an amount equal to not less than 90% of the contract value of all materials shipped, stored or ready for shipment; and not less than 90% of the contract value of the erection performed during the preceding month; and shall pay the remainder within 10 days after the completion of the steel contract; but the amount reserved by the Buyer shall at no time exceed double the contract value of the work remaining yet to be done.

4. When the material which is not to be erected by the Seller is sold to a Buyer whose credit has been established with the Seller, terms net cash for contract value of each shipment. Payments to be made on the 10th day of the month following shipments.

5. Unless otherwise agreed to, when material is sold delivered at, or freight is allowed to destination, the Buyer shall pay freight charges and the Seller shall accept receipted freight bills as cash to apply on matured payments due on or after arrival at destination of materials covered by such freight expense bills.

6. Payments shall all be considered to be due and shall be paid at the time specified, regardless of the final settlement for the building as a whole. or for the work of any other trade; and when the contract is with a general contractor the payment for steel shall not be delayed by such general contractor pending his receiving estimates of payments from the owner.

7. Amounts past due shall bear interest at the maximum lawful rate.

STANDARD FORM OF PROPOSAL

The Seller for the consideration of.................................
hereby agrees to furnish all the materials and to perform all of the labor in accordance with the conditions of the Code of Standard Practice of the American Institute of Steel Construction dated October 1st, 1924, for furnishing and erecting the...
....
for...
located at...
as shown on the drawings...
and as mentioned in the specifications for..........................
pages...................

Terms of payment shall be in accordance with the above mentioned Code of practice, except as follows...
....

The Seller further agrees to furnish such material and complete such labor within the following time..
....

The Buyer shall furnish complete information within.................
days to enable the Seller to complete all necessary shop drawings.

Extra materials and labor furnished by the Seller shall be invoiced to the Buyer at their full cost plus a profit of..............................
per cent.

Inasmuch as materials are subject to prior sale, this proposal is made for acceptance on or before....................and the price is subject to change without notice.

Accepted By:

....

....

Herein designated as the Buyer
or his authorized agent

Date of Acceptance:

....

Witnessed By:

....

....

SIGNED BY

....

....

....

Herein designated as Seller

....

Date...........................

REALIZING that the existing empirical methods of considering fire hazards and fire protection have been unsatisfactory to the construction industries, the American Institute of Steel Construction, Inc., asked a committee of prominent engineers to undertake the preparation of a Specification that would deal with these questions from a rational standpoint.

The resulting specification, we believe, constitutes a most important development to the construction industry.

The personnel of this committee is as follows:

H. G. BALCOM—

Mem. American Society of Civil Engineers
Mem. American Society for Testing Materials
Consulting Engineer, New York City

FRANK BURTON—Chairman of Committee

Past President, Building Officials Conference
Past President, Detroit Engineering Society
Mem. American Chemical Society
Consulting Engineer, Detroit, Mich.

A. R. ELLIS—

Mem. American Society for Testing Materials
Mem. American Society of Municipal Engineers
Mem. American Welding Society
Mem. Engineers Society of Western Pennsylvania
Mem. National Electric Light Association
General Manager, Pittsburgh Testing Laboratory, Pittsburgh, Pa.

S. H. INGBERG—

Mem. Western Society of Engineers
Mem. American Society for Testing Materials
Mem. American Concrete Institute
Mem. National Fire Protection Association
Assoc. Mem. Building Officials Conference
Senior Engineer, United States Bureau of Standards

RUDOLPH P. MILLER—

Mem. American Institute of Consulting Engineers
Mem. American Society of Civil Engineers
Mem. American Society for Testing Materials
Past President, Building Officials Conference
Past President, National Fire Protection Association
Mem. United States Department of Commerce Building Code Committee
Consulting Engineer, New York City

F. E. TURNEAURE—C. E., D. Eng.

Mem. American Association for Advancement of Science
Mem. Western Society of Engineers
Mem. American Railway Engineering Association
Mem. American Society of Civil Engineers
Mem. Society for Promotion of Engineering Education
Dean, College of Mechanics & Engineering, University of Wisconsin, Madison, Wis.

STANDARD SPECIFICATION FOR FIRE-PROOFING STRUCTURAL STEEL BUILDINGS

October 8th, 1927

Foreword

The Specification of the American Engineering Standards Committee for Fire Tests of Building Construction and Materials as published by the American Society for Testing Materials, serial designation C-19-26T, shall apply so far as it defines test procedure. The present specification provides an alternate method of defining the end point of the tests which is based on the maximum temperatures at which the structural steel is permitted to carry the stresses used in the design.

It is not intended that this specification will cover fire hazards that may occur during construction.

It is contemplated that the exterior and interior walls and the floor or roof slabs of the building will confine the fire to its place of origin without protection by automatic sprinklers or manual fire protection.

Such data regarding the fire resistance of structural steel members, and the insulating properties of materials, as have been derived in accordance with the specification C-19-26T, and that are found applicable to types of building members treated in this specification, may be used.

Data of this nature regarding columns were developed in a co-operative series of fire tests by The Associated Factory Mutual Laboratory, The Underwriters' Laboratories, and the Bureau of Standards, the results of which are given in the publication "Fire Tests of Building Columns," obtainable from the Underwriters' Laboratories, Chicago, Ill., or the Superintendent of Documents, Washington, D. C.

Since this specification deals with the question of fire protection from a relatively new standpoint, it has been considered advisable to incorporate some data that is informative, which if attached as notes or appendix might be overlooked.

STANDARD SPECIFICATION FOR FIRE-PROOFING STRUCTURAL STEEL BUILDINGS

October 8th, 1927

SECTION 1. PURPOSE AND SCOPE

The purpose and scope of this specification is:—

(a) To define basic conditions relative to the insulation necessary to protect structural steel when exposed to fire hazards, and thus enable engineers to design and classify steel structures for temperature resistance.

(b) To provide data that will enable the classification of fire hazards, and to rate them on the basis of their relative intensity and duration as compared to an established standard time-temperature hazard.

(c) To define the physical characteristics of structural steel within the temperature range that it is capable of carrying the working stresses used in designing, thus making possible the substitution of temperature determinations for the loading of test specimens during fire tests.

(d) To define fire test procedure that will give data on a uniform basis regarding the insulating properties of different fire resistive insulators.

SECTION 2. FIRES

(a) The intensity and duration of fires is variable, but for the purpose of this specification all fires shall be classified, with regard to their intensity and duration, on the basis of the average time-temperature definitions as set forth in the tentative specification for fire tests on building construction and materials as prepared by the sectional committee on Fire Test Specifications under the joint sponsorship of the United States Bureau of Standards, the American Engineering Standards Committee Fire Test Group, and the American Society for Testing Materials, in accordance with the procedure of the American Engineering Standards Committee, and published by the American Society for Testing Materials under serial designation C-19-26T.

(b) The time-temperature definition of the above referred to specification is given by the accompanying table and shown by the curve in Fig. No. 1.

1000° F.	at	5 minutes duration
1300° F.	at	10 minutes duration
1550° F.	at	30 minutes duration
1700° F.	at	1 hour duration
1792° F.	at	1 hour and 30 minutes duration
1850° F.	at	2 hours duration
1925° F.	at	3 hours duration
2000° F.	at	4 hours duration
2075° F.	at	5 hours duration
2150° F.	at	6 hours duration
2225° F.	at	7 hours duration
2300° F.	at	8 hours duration

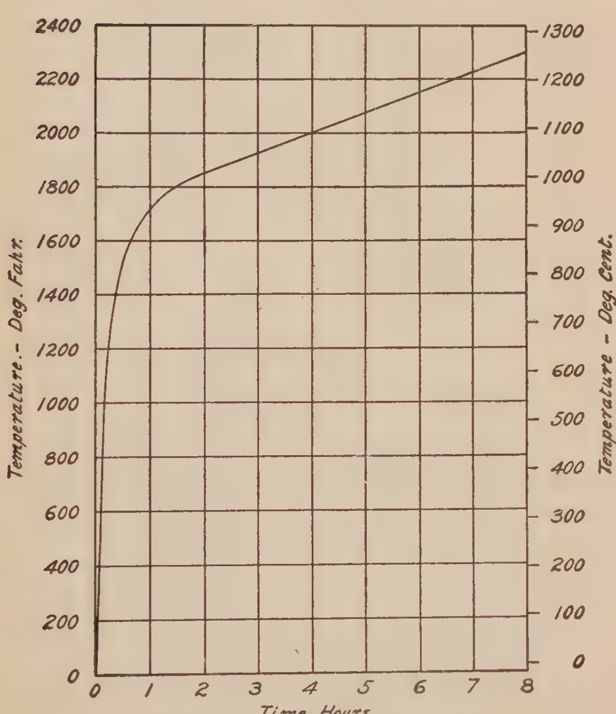


Fig. I. Time Temperature Curve.

(c) The temperature in the combustion chamber fixed by the curve shall be deemed the average obtained from the readings of several thermo-couples (not less than three) symmetrically located to show the temperature near all parts

of the specimen being tested, the thermo-couples being enclosed and sealed in standard porcelain tubes ¾ inch outside diameter, and with walls ⅛ inch thick. The exposed length of the thermo-couples and porcelain tubes shall extend not less than 12 inches into the combustion test chamber. Pyrometers or thermocouple protecting tubes which are not standard may be used if under test conditions they give readings that are within the limits of accuracy that apply for furnace-temperature measurements. Other conditions defining the control of fire tests shall be as fixed by the above referred to specifications.

SECTION 3. FIRE HAZARDS

(a) For the purpose of this specification fire hazards shall be classified in accordance with the nature and combustibility of the materials which the buildings contain.

(b) Fire resistive buildings shall be rated as to fire hazards due to interior fires on the basis of the temperature which their combustible contents will produce, and the time that is necessary to complete the burning of the combustible contents as compared to the standard time-temperature definition above given.

(c) The steel in the exterior walls of buildings shall be adequately protected against existing or probable maximum future exterior fire hazards.

(d) The occupancy rating of the fire hazards of fire resistive buildings or parts thereof, shall be based upon the quantity of combustible contents per square foot of floor, and the equivalent intensity of fire which the contents will produce as compared to the standard time-temperature curve.

(e) All fire resistive buildings, together with such parts as are used for the storage or handling of extra quantities of combustible materials, shall be fireproofed to protect them against maximum fire hazards within any section having fire separation from the remainder of the building, in accordance with the measured quantities of contained combustible materials including wood floor covering and wood trim. The burning out tests conducted by the Bureau of Standards with office occupancy and record storage, indicate the following equivalent fire hazard will approximately apply:

10 pounds per square foot constitutes a 1 hour fire hazard
15 pounds per square foot constitutes a 1½ hour fire hazard
20 pounds per square foot constitutes a 2 hour fire hazard
30 pounds per square foot constitutes a 3 hour fire hazard
40 pounds per square foot constitutes a 4½ hour fire hazard
50 pounds per square foot constitutes a 6 hour fire hazard
60 pounds per square foot constitutes a 7½ hour fire hazard

The maximum fire hazard based on the weight of combustible materials shall be determined from the floor area of any one bay of the building or fire division thereof.

The above classification when applied to office equipment is based upon the use of wood furniture and shelving. Other burning out tests of offices equipped with metal furniture and shelving, and with papers exposed by opened drawers, show a very substantial reduction of the fire hazard.

The combustible contents of some fire resistive buildings may weigh less than 10 pounds per square foot of floor, but for the purpose of this specification no building shall be considered fire resistive that is not constructed to resist a fire of at least one hour standard duration with the pertaining safety factor.

SECTION 4. STEEL

(a) The occasion for fireproofing structural steel is to insulate it against a rise of temperature that would seriously impair its ability to sustain the loads at the unit stresses used in the design.

(b) This specification applies only to steel of the quality defined by the A. S. T. M. Standard Specification for Structural Steel for Buildings.

(c) The maximum working stresses for structural steel shall be those fixed by the Standard Specification for Structural Steel for Buildings of the American Institute of Steel Construction, dated June 1st, 1923.

(d) Under the conditions of this specification the structural steel shall carry the entire load, except that beams, girders, or trusses, may have wall bearing supports, and no stress shall be assumed as carried by the fireproofing materials, when subjected to a fire. In cases where the original design considers a part of the compression stresses as carried by some of the material used for fireproofing, a corresponding percentage of the stress may be considered as carried by the fireproofing material during a fire.

(e) In steel frame buildings or in buildings with part wall bearing, the skeleton frame shall be considered as the columns, and the girders, beams, trusses and spandrels having direct connections to the column. The secondary members of floor or roof panels are those which have no direct connections to the columns of the building. Supplementary steel members shall be those members used in connection with openings in outside wall or interior partitions, and which do not transmit the loads which they may carry through direct connections to the skeleton frame or secondary members. Masonry bearing lintels spanning openings greater than six feet shall be considered secondary members.

(f) The strength of structural steel at approximately 550° F. is about 25% greater than its normal temperature strength, and at 800° F. its strength is approximately the same as its normal temperature strength.

At a temperature of 1000° F. the compression strength of steel is approximately the same as the maximum permissible working stress in columns, and under a rare hazard of fire it shall be permissible for insulated steel columns to carry their working stresses when the average temperature at any critical cross

section does not exceed 1000° F., or when the maximum temperature at the critical cross section does not exceed 1200° F.

If the maximum working stress in tension or compression is 18,000 pounds per square inch in any member or critical flange of a member resisting bending moments, it shall be permissible for the member to carry its maximum working stress if the average temperature does not exceed 1000° F., or the maximum does not exceed 1200° F. at any cross section of the member, or its critical flange. If higher working stresses are used, proper consideration shall be given to extra insulation against temperature.

(g) If structural steel of special manufacture is used at higher working stresses than those fixed by this specification, its strength as compared to the steel of this specification at high temperatures shall be determined, and it shall be insulated against a rise of temperature that will leave its strength proportionately above the working stress.

(h) The average coefficient of expansion for structural steel between the temperatures of 200° F. and 1100° F. is given by the formula

$$C = .0000061 + .0000000022\,t$$

in which C is the coefficient of expansion for each degree F., and t is the temperature Fahr.

From 1100° F. to 1400° F. there is a slight variation in the coefficient, and below 200° F. the variation is less than that at the higher temperatures.

(i) Structural steel maintained at various constant temperatures has a uniform coefficient of elasticity up to the elastic limit stress, but between the elastic limit stress and the yield point stress, the rate of deformation with stress is a variable. If a member is subject to bending which produces stresses in the extreme fibre above the elastic limit it results in the extreme fiber and a portion of the adjacent fibers nearer the neutral axis carrying approximately the same stresses, and accounts for yield points determined by flexure being sometimes considerably higher than yield points determined by axial tension.

The coefficient of elasticity of steel decreases as the temperature increases, and the initial or tangent coefficient of elasticity for temperatures between 200° F. and 1300° F. is given approximately by the formula

$$E = 32400000 - 17000\,t$$

in which E is the initial or tangent coefficient of elasticity, and t is the temperature Fahr. Between room temperature and 200° F. there is a smaller variation in E.

The formula $E = 32400000 - 17000\,t$ does not apply for stresses above the elastic or proportional limit which varies with the temperature approximately as follows:

200° F.	Elastic Limit	= 33000 #	per sq. inch
300° F.	Elastic Limit	= 28000 #	per sq. inch
500° F.	Elastic Limit	= 16000 #	per sq. inch
700° F.	Elastic Limit	= 12000 #	per sq. inch
900° F.	Elastic Limit	= 8000 #	per sq. inch
1100° F.	Elastic Limit	= 5000 #	per sq. inch
1300° F.	Elastic Limit	= 2000 #	per sq. inch

SECTION 5. FIREPROOFING MATERIALS

(a) The insulating material used shall be so applied that the difference in temperature of the steel in any cross section shall not set up serious internal or buckling stresses, and so that such variation as exists will be symmetrical about the axes of compression members.

(b) Fire resisting insulating material shall continue to function within the temperature range of its use, and shall be so applied that it will not crack, spall, or buckle to seriously expose the steel to direct heat from fire.

(c) If the insulating of columns contemplates the use of air spaces between the steel and the insulator, there shall be fire stops placed at the floor levels.

SECTION 6. TESTS

(a) In lieu of the test procedure described in C-19-26T the following procedure may be employed in the preparation of data regarding the fire resistive properties of insulating materials that are used under the conditions of this specification.

(b) If the insulation contemplates the use of air spaces between the steel and the insulator, the ends of the test specimen shall be thoroughly fire-stopped to prevent the escape of heat from the air spaces.

(c) Temperature reading of all thermo-couples both in the combustion chamber and on the steel shall be made every five minutes during the first hour of the test, but may be read at 15 minute intervals thereafter.

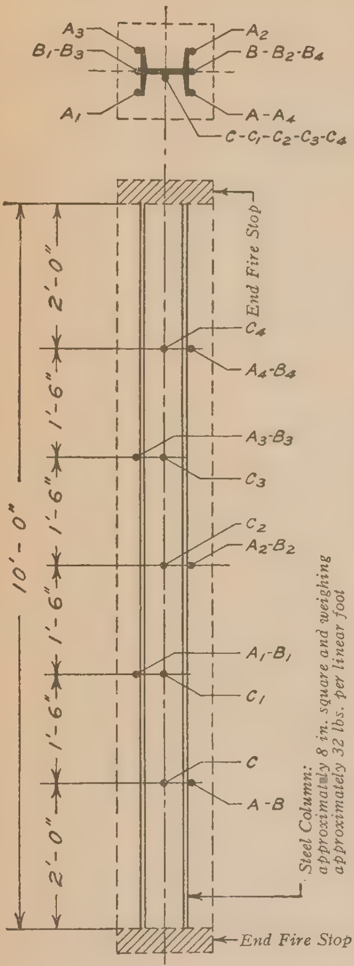


Fig. 2 Column Fireproofing Test

(d) Test specimens for columns shall consist of a rolled steel H section 10 feet long with not less than 15 thermo-couples arranged as shown in figure #2. The steel H section shall be approximately 8″ square and weigh approximately 32 pounds per linear foot. The thermo-couples A, B, C — A_1, B_1, C_1, — A_2, B_2, C_2, — A_3, B_3, C_3, — A_4, B_4, C_4, shall be placed against or in the steel in the positions shown to give the temperature of the steel whether the fireproofing is solid or includes an air space. Column tests shall be conducted with the test specimen in a vertical position. The average temperature of the steel at different cross sections as found by the readings of thermo-couples A, B, C, — A_1, B_1, C_1, etc., shall not exceed 1000° F., and the maximum reading for any thermo-couple shall not exceed 1200° F. The average temperature of the steel as found for any cross section by the reading of A, B, C, — A_1, B_1, C_1, etc., will be obtained for this test specimen by the following formula:

$$\text{Average} = .39 \times \text{A (reading)} + .5 \times \text{B (reading)} + .11 \times \text{C (reading)}$$

Example: If A reading is 1200° F., B reading is 1100° F., and C reading is 1000° F., the average for the area is $.39 \times 1200 + .5 \times 1100 + .11 \times 1000 = 1128°$ F.

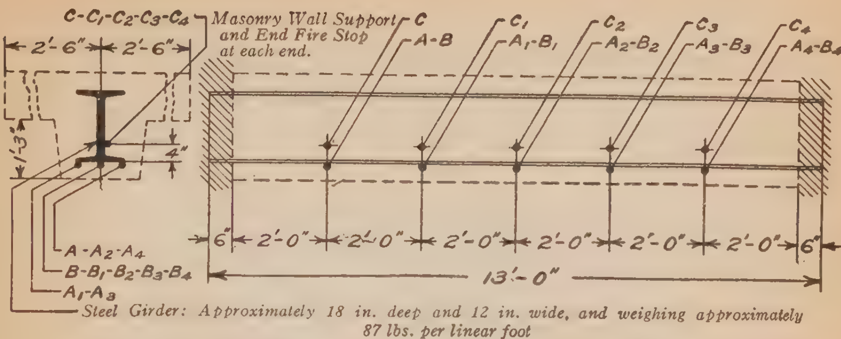


Fig. 3. Girder Fireproofing Test for Paneled Ceiling

(e) The test specimen for girders in paneled ceiling construction shall consist of a rolled steel girder 13 feet long with not less than 15 thermo-couples arranged as shown in Fig. No. 3. The steel girder section shall be approximately 18″ deep with a flange approximately 12″ wide and weigh approximately 87 pounds per linear foot. The panel projection below the ceiling shall be about 1′–3″, and the thermo-couples A,B,C, — A_1, B_1, C_1, etc., shall be placed against or in the steel in the position shown to give the temperature of the steel whether the fireproofing is solid or includes an air space. The specimen shall be tested in a horizontal position. The average temperature of the steel of the flange as found from the readings of thermo-couples A,B,C, — A_1, B_1, C_1, — A_2, B_2, C_2, etc., shall not exceed 1000° F., and the maximum reading for any thermo-couple shall not exceed 1200° F. The average temperature of the steel of any flange cross section as found from the reading of A, B, C, —A_1, B_1, C_1, etc., will be obtained for this test specimen by the following formula:

$$\text{Average} = .43 \times A\ (\text{reading}) + .5 \times B\ (\text{reading}) + .07 \times C\ (\text{reading})$$

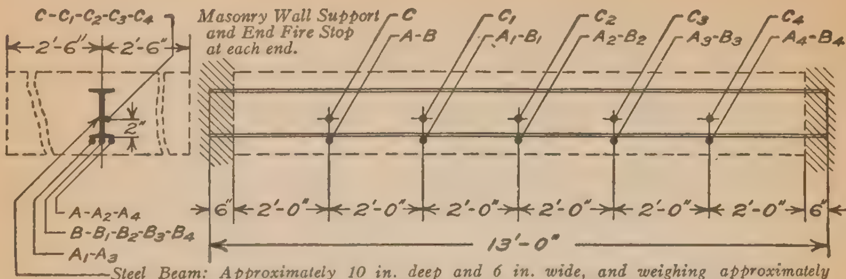


Fig. 4. Beam Fireproofing Test for Flush Ceiling

(f) The test specimen for flush ceiling floor construction shall consist of a rolled steel beam 13 feet long with not less than 15 thermo-couples arranged as shown in Fig. No. 4. The steel beam shall be approximately 10″ deep with a flange approximately 5¾″ or 6″ wide, and shall weigh approximately 23 pounds per linear foot. The thermo-couples A,B,C, — A_1, B_1, C_1, etc., shall be placed against or in the steel in the position shown to give the temperature of the steel whether the fireproofing is solid or includes an air space. The specimen shall be tested in a horizontal position. The average temperature of the steel of the flange as found from the readings of thermo-couples A,B,C, — A_1, B_1, C_1, etc., shall not exceed 1000° F., and the maximum reading for any thermo-couple shall not exceed 1200° F. The average temperature of the steel of any flange cross section as found from the reading of A, B, C, — A_1, B_1, C_1, etc., will be obtained for this test specimen by the following formula:

$$\text{Average} = .43 \times \text{A (reading)} + .5 \times \text{B (reading)} + .07 \times \text{C (reading)}$$

SECTION 7. SAFETY FACTOR

(a) Steel buildings whose condition of exterior exposure and whose contents under fire hazards will not produce a temperature greater than 800° F. in the steel, shall be considered fire resistive without insulating protection for the steel.

(b) If the steel work has an insulating protection, the safety factor shall be based on the fireproofing material providing protection for a greater period of time than the combustible contents of the building will burn as shown in Section 3, Par. e. of this specification. The safety factor for all skeleton frame and secondary members shall be 1½. For example: if a building contains 10 pounds of combustible material per square foot of floor, and has a fire hazard of one hour duration, the steel work shall be protected against the temperatures defined in this specification for 1½ hours.

Supplementary members shall not require insulating protection.

MINIMUM LIVE LOADS ALLOWABLE FOR USE IN THE DESIGN OF BUILDINGS

As recommended by the
Building Code Committee of the Bureau of Standards,
United States Department of Commerce

1. Definitions.

1. *Dead Load.*—The dead load in a building includes the weight of walls, permanent partitions, framing, floors, roofs, and all other permanent stationary construction entering into a building.

2. *Live Load.*—The live load includes all loads except dead loads.

2. General.

Buildings and all parts thereof shall be of sufficient strength to support safely their imposed loads, live and dead, in addition to their own proper dead load; provided, however, that no building or part of a building shall be designed for live loads less than those specified in the following sections.

3. Human Occupancy.

1. For rooms of private dwellings, hospital rooms and wards, guest rooms in hotels, lodging and tenement houses, and for similar occupancies, the minimum live load shall be taken as 40 pounds per square foot uniformly distributed, except that where floors of one and two family dwellings are of monolithic type or of solid or ribbed slabs the live load may be taken as 30 pounds per square foot.

2. For floors for office purposes and for rooms with fixed seats, as in churches, school classrooms, reading rooms, museums, art galleries, and theaters, the minimum live load shall be taken as 50 pounds per square foot uniformly distributed. Provision shall be made, however, in designing office floors for a load of 2,000 pounds placed upon any space 2½ feet square wherever this load upon an otherwise unloaded floor would produce stresses greater than the 50-pound distributed load.

3. For aisles, corridors, lobbies, public spaces in hotels and public buildings, banquet rooms, assembly halls without fixed seats, grandstands, theater stages, gymnasiums, stairways, fire escapes or exit passageways, and other spaces where crowds of people are likely to assemble, the minimum live load shall be taken as 100 pounds per square foot uniformly distributed. This requirement shall not apply, however, to such spaces in private dwellings, for which the minimum live load shall be taken as in paragraph 1 of this section.

4. Industrial or Commercial Occupancy.

In designing floors used for industrial or commercial purposes, or purposes other than previously mentioned, the live load shall be assumed as the maximum caused by the use which the building or part of the building is to serve. The following loads shall be taken as the minimum live loads permissible for the occupancies listed, and loads at least equal shall be assumed for uses similar in nature to those listed in this section.

Floors used for:	Minimum Live Load in lbs. per sq. ft.
Storage purposes (general)	250
Storage purposes (special)	100
Manufacturing (light)	75
Printing plants	100
Wholesale stores (light merchandise)	100
Retail salesrooms (light merchandise)	75
Stables	75
Garages	
All types of vehicles	100
Passenger cars only	80
Sidewalks—250 or 800 pounds concentrated, which ever gives the largest moment or shear.	

5. Roof Loads.

Roofs having a rise of 4 inches or less per foot of horizontal projection shall be proportioned for a vertical live load of 30 pounds per square foot of horizontal projection applied to any or all slopes. With a rise of more than 4 inches and not more than 12 inches per foot a vertical live load of 20 pounds on the horizontal projection shall be assumed. If the rise exceeds 12 inches per foot no vertical live load need be assumed, but provision shall be made for a wind force acting normal to the roof surface (on one slope at a time) of 20 pounds per square foot of such surface.

6. Allowance for Movable Partition Loads.

Floors in office and public buildings and in other buildings subject to shifting of partitions without reference to arrangement of floor beams or girders shall be designed to support, in addition to other loads, a single partition of the type used in the building, placed in any possible position.

7. Reductions in Live Loads.

Except in buildings for storage purposes the following reductions in assumed total floor live loads are permissible in designing all columns, piers or walls, foundations, trusses, and girders.

Reduction of total live loads carried

	Per cent
Carrying one floor	0
Carrying two floors	10
Carrying three floors	20
Carrying four floors	30
Carrying five floors	40
Carrying six floors	45
Carrying seven or more floors	50

For determining the area of footings the full dead loads plus the live loads, with reductions figured as permitted above, shall be taken; except that in buildings for human occupancy, listed in section 3, a further reduction of one-half the live load as permitted above may be used.

The Historical Development

of

STEEL

and

IRON

The two words, Steel and Iron, have been used so extensively to indicate the same thing that it is uncertain what should be the proper distinction between the two materials. However, the popular conception is that steel means a more refined state than the word iron.

Under modern conditions of production, the first state of iron after refinement from the ore is usually known as cast iron, and a continued refinement of cast iron is usually called steel; and it is the popular conception that a further refinement of the steel produces wrought iron. As a matter of fact, in the early production wrought iron was developed directly from the ore in a plastic condition and it was only after many centuries that the iron could be produced from the ore in a molten condition, which permitted it being poured into molds to form castings.

Next to oxygen, silicon and aluminum, iron is the most widely distributed and largest part of the solid material in the earth, and is about 4⅛% of the solid earth crust.

For many years steel has been considered the index of the commercial activities of the country, but in a broader sense, it has from the beginning of history, been an accurate measure of the progress of civilization since it is the medium through which all of our attainments are possible, and without it we must have continued in a savage state. It is the only substance that

can be hardened to form the tools by which all of our necessities are made, including wood work, machinery, transportation, in all forms, agricultural implements, steam engines, and since it alone possesses magnetic properties, all our electrical devices and developments depend upon it.

It is doubtful whether iron was known when the pyramids were made some 6000 years ago, but it was used by the Hebrews, Assyrians, Phoenicians, Greeks, and by the Romans, who found it being used by the Britains at the time of Caesar's invasion. Through all of this time, and up to about 1400 A. D. iron was produced in very small quantities, and in a shallow saucer shaped forge in which the ore and charcoal were mixed and from which the iron was thus separated. It would therefore seem natural that up to this time iron would be used largely for weapons of combat and for small tools.

About 1400 A. D. the first masonry furnace resembling the principles of the modern blast furnace was made in Europe, and about one hundred years later, it was introduced into England. Previous to this all of the refining was accomplished by hand puddling, and forging, and it was only after the furnace method was developed, that quantities could be made large enough to use for castings. In fact it was impossible up to this time to develop temperatures that would melt the material.

Following this and for nearly three hundred and fifty years the methods of refinement were limited to puddling in a small reverberatory furnace from which the product was removed, as a puddle ball, and subjected to forging. The next outstanding accomplishment was the Bessemer converter developed between 1850 and 1860 in England by Henry Bessemer, and in America by William Kelly of Eddyville, Ky. Bessemer's financial strength enabled him to absorb his American contemporary and the process has since born his name. Briefly, the Bessemer process consists in passing air through a melted cast iron which contains combustible impurities in such quantities that chemical reaction is generated to raise the temperature to such a point that undesirable impurities are removed from the molten mass. This process is accomplished in about fifteen minutes, but its application is limited to iron which contains combustible materials in quantities that make the process workable.

While Bessemer was developing his converter, William Seimens was working on the open hearth process, and built the first gas burning furnace of this type in 1861. The success of the Bessemer even with its limitations as fixed by the nature of the ores required, and the resulting product, established that an almost unlimited market existed for an economically produced steel. This resulted in the vigorous development of the open hearth which was not so restricted as to the materials used, and while the process is longer than the Bessemer, the product is more uniform in chemical and physical properties, and soon outstripped its rival for public favor. Both processes made possible the casting of large ingots from which various shapes could be rolled, and by 1892 had practically eliminated sections of wrought iron which had to be made by welding small bars together through a re-

rolling process such as is still used for stay bolt iron and chain iron. As the development of steel progressed, the sky line of our cities changed rapidly. The electric furnace is following the open hearth and is capable of producing a material of almost any preconceived chemical analysis, but so far at a cost that prevents its entering into competition with the Bessemer or the open hearth for ordinary structural grade steel. The remarkable precision of chemical and physical properties that are uniformly attained by these processes is unknown to any other industry, and is illustrated by the fact that the chemical properties are expressed in hundredths of a per cent, and it is doubtful whether drops from a medicine dropper used in filling prescriptions are closer than 5% of each other. Throughout all of the processes of treating the ore and finishing through the Bessemer, the open hearth, or the electric furnace, great care is used in the selection of the fluxes, and the furnace linings by means of which the chemical properties of the material are determined.

In all of these processes, the method of refining involves the treatment of molten material, but it has been found commercially practicable to refine certain grades of cast iron, and change it from a crystalline to a malleable structure without heating it to the melting point.

Remaur in 1722 described the production of ductile castings by processes which removed the carbon from white grey iron by heating it in an oxide. This process is still used in Europe but in America it has been supplanted by the Boyden process, which was introduced in 1826. The Boyden process results in what is called malleable cast iron, which resembles the ordinary grey cast iron, only in that both are cast in molds.

Grey iron castings contain about 2½% graphite, which exists as flat flakes of free carbon and gives the fractured material a granular appearance. By subjecting certain grades of grey iron castings for about three days to a temperature of approximately 1300° F. but not higher than 1700° F. a part of the carbon is removed, and the remaining graphite flakes are converted into small carbon nodules which are scattered throughout the material. This results in a dead soft malleable iron.

Malleable cast iron (A. S. T. M. Specifications) is required to have a tensile strength, as measured in a test specimen of prescribed form, of 50,000 lbs. per square inch, and a minimum elongation of 10%. The point at which a test specimen of malleable iron will elongate about .01″ in 2″ is sometimes spoken of as the yield point, which is about 35,000 lbs. per square inch. The shearing strength is about 45,000 lbs. per square inch.

The material flows under compression at stresses above the yield point, and its ultimate strength by fracture in compression is therefore not determinable. The coefficient of elasticity or Young's modulus in tension or compression is about 25,000,000.

The following table is reproduced from a volume entitled "The Making, Shaping and Treating of Steel,"* and illustrates the approximate chemical properties which distinguishes pig iron, plain steel, and wrought iron.

Chemical Relations of Pig Iron, Wrought Iron and Plain Steel

	PER CENT. OF					
Name	Iron	Carbon	Manganese	Sulphur	Phosphorus	Silicon
Pig Iron	91 —94	3.50—4.50	.50—2.50	.018—.100	.030—1.00	.25—3.50
Plain Steel	98.1—99.5	.07—1.30	.30—1.00 (.03—.10 as cast)	.020—.060 (.120)	.002—.100	.005— .50
Wrought Iron	99.0—99.8	.05— .25	.01— .10	.020—.100	.050— .20	.02— .20

** Note.—"The making, shaping and treating of steel" is published by the Carnegie Steel Co. and should be read by every person interested in steel. It can be obtained from the Bureau of Instructions of the Carnegie Steel Co. at Pittsburgh, Pa. Price $7.50.*

Physical Properties of Steel and Iron

IRON

Pure iron is almost unknown commercially. It is a grayish white color and soft compared with carbon steel. It is malleable, ductile, and magnetic. It is 7.78 times heavier than water, and in its commercial forms melts at about 1520°C. or about 2770°F.

The presence of the various elements which are combined with iron in its commercial forms lowers this melting point very rapidly. The ultimate strength is approximately 38,000 pounds per square inch and the elastic limit about 20,000 pounds per square inch.

STRUCTURAL STEEL

Structural steel weighs .2833 pounds per cubic inch or 490 pounds per cubic foot. It is therefore about 7.85 times heavier than water.

ELASTICITY

Structural steel is perfectly elastic below the stress per square inch which is called the yield point, and beyond this yield point there will be permanent set or deformation when the load is removed. Just below the yield point, and usually within 1000 pounds per square inch of it is the elastic limit, below which the elongation or deformation is always exactly proportional to the stress per square inch. The ratio of elongation to the stress per square inch is called the coefficient of elasticity, the modulus of elasticity, or sometimes Young's Modulus. It may otherwise be defined as that stress per square inch, which in tension would double the length of a test specimen assuming that uniform elasticity were possible throughout the experiment. For structural grades of steel, the coefficient of elasticity is 29,000,000 pounds; that is, a bar 1 square inch in area will stretch one twenty-nine millionth (1/29,000,000) of an inch for each inch of length and for each pound of stress. It has been found by innumerable experiments that the physical properties of steel cannot be changed regardless of the number of times a load may be applied to it so long as the stresses produced do not exceed the elastic limit. It has also been found that when steel is loaded to produce stresses beyond its yield point, and therefore producing permanent set, that the material will have a higher elastic limit and yield point if the original stresses are

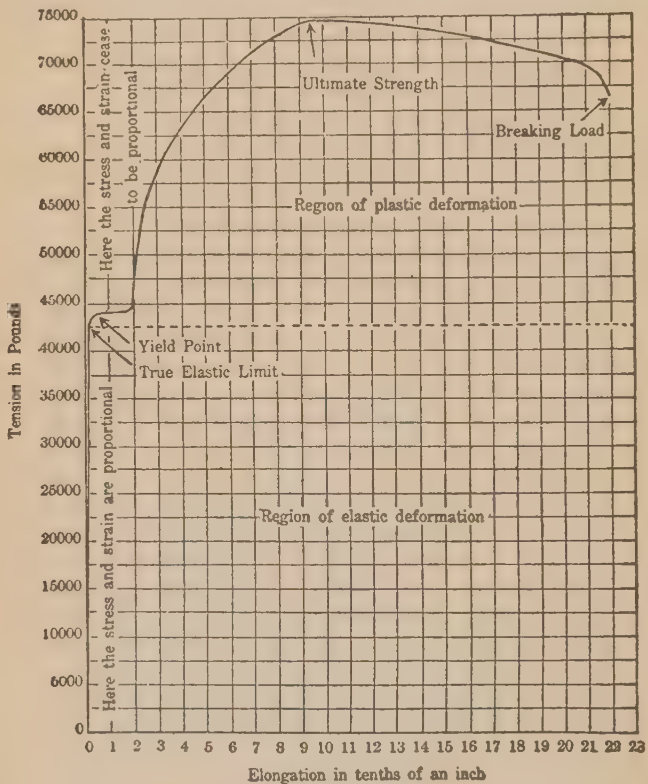
removed. It is this principle that is used in the manufacture of cold rolled, or cold drawn steel.

The following diagram is reproduced from "The Making, Shaping, and Treating of Steel," and graphically illustrates the performance of the material within the various ranges of its strength. The chart represents a specimen whose dimensions before pulling were as follows:

8″ long———1.41″ wide———.86″ thick

With an area of 1.213 square inches.

The elastic limit per square inch was 36,770 lbs.—the ultimate strength per square inch was 61,500 lbs.—the elongation in 8″ 27.5%—and the reduction of area 50.5%.



Graph Representing the Pulling of a Structural Steel Test Piece.

The elastic limit and ultimate strength of steel depend upon not only the chemical composition of the material, but also upon the amount of work done on the material in producing it, and the temperature at which the work is finished. While there may exist among engineers a division of opinion as to the importance of the percentage of elongation and the reduc-

tion of area, there is no difference regarding the importance of the elastic limit and the ultimate strength.

The effect of carbon on the ultimate strength and elastic limit is to increase them, but at the same time it also results in a harder steel, and for that reason in ordinary structural grades it is usually below .25%. Manganese also has the effect of increasing the elastic limit and ultimate strength, but not to the extent produced by carbon. In large quantities it has the effect of producing a material very difficult to manufacture. One of the important effects of manganese, however, is that it neutralizes the evil effects of sulphur. Sulphur up to 0.1% has little or no influence on the ductility or strength of steel at ordinary temperatures. It does, however, have the effect of producing what is known as the red short conditions which means that the material is difficult to work at a red heat.

Phosphorus for many years has been considered responsible for steel at ordinary temperatures being brittle or technically termed, cold short, but it is doubtful whether quantities less than .1% have any very marked influence. It does increase the hardness and the tensile strength of the steel and reduces the ductility. Some experimenters have found that the evils produced by phosphorus are not the same, and have found that under apparently similar conditions the effect is entirely different, which indicates that it should be considered as a treacherous element. Some users refuse to accept steel which contains a higher percentage than .04%.

Silicon is now considered beneficial up to .75%, and up to this point it increases the elastic limit and the ultimate strength of the material without interfering with its ductility.

The Strength of Steel at High Temperatures

Research on the strength of steel at high temperatures was conducted by Mr. J. F. Howard, Engineer in charge of the U. S. testing machine at Watertown, Mass., and the results published in the Iron Age of April 10, 1890. In these tests the method of measuring temperature was not exact. In 1913 tests were made at the Elwood works laboratory of the National Tube Company. Both of these series were made primarily for data that would apply to power plant equipment. Further research was made by the Bureau of Standards in which the scope was extended to include data applying to fireproofed structural steel. This data was presented in June, 1926 before the A. S. T. M. in a paper by S. H. Ingberg and P. D. Scale. The National Tube Company conducted their tests in tension on material of about the same chemical analysis as Structural Steel and the Bureau of Standards tests were conducted in compression on cast iron and light rolled structural shapes.

All tests indicate that the ultimate strength increases about 25% when the temperature reaches approximately 500° to 600°F., and that it returns to its normal temperature strength at about 800° F. The ultimate strength at 1200° F. is about one-third the ultimate strength at normal temperature.

It is difficult to devise a satisfactory method for determining the yield point at high temperatures. At normal temperature there is a difference of from 2000 # to 3000 # between the proportional or elastic limit and the yield point, but as the temperature increases the difference between these points increases and the straight line of the stress-strain curve which repre-

sents proportional elasticity shortens more than the yield point decreases. There is an increase in the brittleness at the temperature of maximum strength and the National Tube Company's tests show that the percentage of elongation and reduction of area decrease also at this point but they increase again as the temperature rises above 500° to 600° F. Other properties at high temperatures are given in the A. I. S. C. fireproofing specification.

This diagram is reproduced from the National Tube Company's Handbook of 1924, with the exception that the temperature readings are given on the Fahrenheit instead of the Centigrade scale.

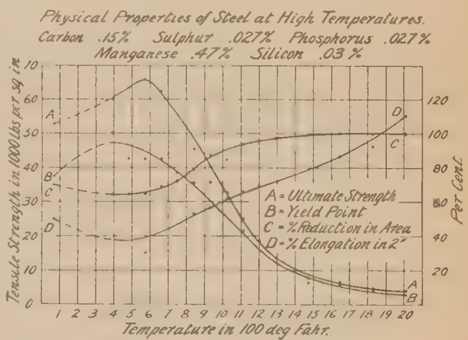
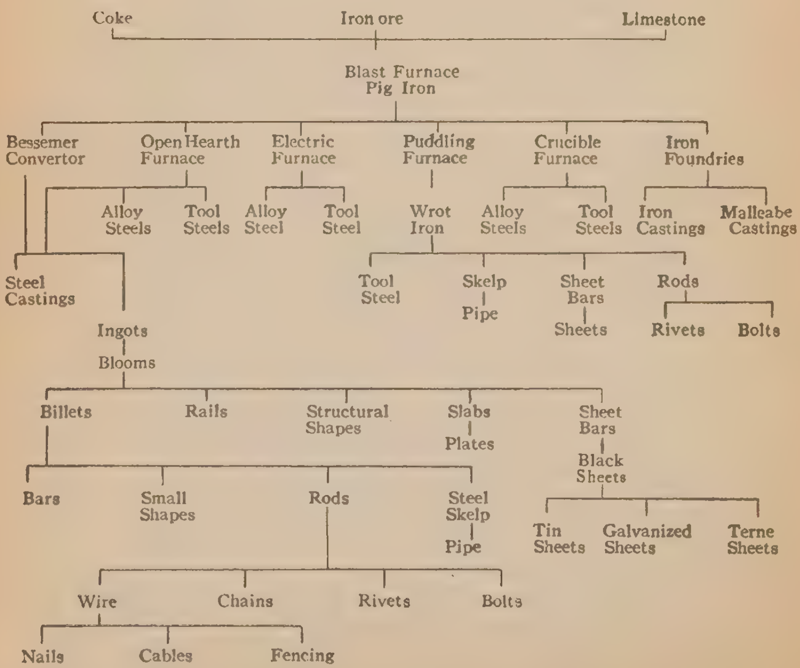


Chart showing the sequence of manufacture of steel and iron products



In connection with the above chart showing the sequence of manufacture, it is practically impossible for a layman to appreciate the innumerable details and conditions that must be fulfilled in every process of manufacture. When however, it is understood that between the blast furnace producing the pig iron, and the rolling mill producing the structural shapes, there is a loss of production amounting to in many cases as much as 25 or 30%, the layman will understand to some degree what is involved when a special analysis of steel is required. It is also of interest to note that for every ton of finished rolled steel that is shipped from a steel plant approximately six tons of ore, fuel, fluxes, refractories, lubricants, etc. must be shipped into the mill. There is every reason to expect that the manufacturers of steel will continue to improve their metallurgical processes and increase the uniformity of the product.

Recently there has been work done on the development of a steel carrying a higher percentage of silicon which has the effect of increasing both the ultimate strength and elastic limit without interfering with the ductility of the product.

Economic Importance of Research

Records of history make it clear that nations incapable of mobilizing their national resources are in constant danger of losing their national existence. It is useless to mobilize a nation's manpower without also having means to properly equip them. Unless our national industries are capable in the time of peace to successfully compete in the world's market with the industries of other nations, they will be of little national value when an international emergency arises.

The Department of Commerce after exhaustive investigation have estimated that more than 30% of our industrial activities, even in the times of peace, are wasted. In a volume which this Department recently issued, they estimated that the automotive industry in 1920 had saved that industry $750,000,000 through the adoption of the standard dimensions recommended by the Society of Automotive Engineers. As a result that industry has enjoyed a prosperity more stable than it has ever experienced in the past; and at the same time the public are buying automobiles at prices lower than they ever existed before.

During the last thirty-five or forty years there has developed an industry between the rolling mills, which produce the steel, and the purchasing public, and in this industry practically every phase has been subject to very wide variation in practice. This variation of practice has made it possible for the irresponsible competition to exert an influence which tends to lower rather than raise the general standard. Since no uniform authority now exists it is evident that the basis of any improvement must be the development of a recognized authority which in the past has not existed.

Previous to 1884 practically all of our structures were fabricated from wrought iron or cast iron, and the introduction of the Bessemer furnace enabled the steel manufacturers to reduce the cost of this product to a point

where it could be economically used in building and bridge construction. About that time various mills issued catalogs or handbooks dealing with the technical matters connected with the design of their products. These handbooks or catalogs have continued to be the principal source of information since that time, and have been used extensively as text books in technical schools. The opposition to the use of Bessemer material was manifested in a vigorous campaign against its use during the period from 1889 to 1891. Gradually the Bessemer furnace has been replaced by the open hearth which was capable of producing a much more uniform and satisfactory material.

The increase in the use of steel for construction purposes led to a demand for technically trained men to direct its uses with the result that our technical colléges have experienced a constantly increased enrollment of students.

During the same period the industry engaged in the design, fabrication and erection of structural steel was developed to a point where it furnishes in the neighborhood of $300,000,000 worth of fabricated structural steel annually. Building codes came into existence but were written principally from the data found in the various mill handbooks or catalogs. About 1900 the American Railway Engineering Association organized a committee on iron and steel structures, who have developed their present Specifications for railway bridges. These Specifications are based upon the original unit stresses recommended by the mills at a time when little information existed regarding live loads, or the proper calculation of the stresses themselves.

At the present time practically all large bridge constructions are designed on unit stresses of from 20,000 pounds per square inch to 24,000 pounds per square inch. There also exists an almost endless number of column formulae which has made it possible to justify almost any practice that may be contemplated. The engineer who designs, the fabricator who manufactures, and the buyer are not in a position to know whether their quotations are based upon the same conditions.

Part II

General Mathematical Tables

An Elementary Discussion of the Relation of External Loads and Internal Stresses

There is probably nothing so dangerous to safe construction as the blind use of empirical formulae. A formula is empirical so far as the user is concerned unless he understands it, and the fact that someone else may understand it does not change its empirical standing to the one who lacks the understanding.

Every engineer and architect now recognizes that an understanding of the relation of external loads to internal stresses in the materials which sustains the loads, is the basis of safety in the design of all structures. The necessity of such an understanding may be looked upon as almost an emergency with the present generation, due to the rapid transition from the "Iron Age" to the "Steel Age" which took place between 1885 and 1893 following the development of temperatures which enabled production of steel ingots from which all our steel products are manufactured. It has resulted in revolution of existing industrial conditions, and the evolution of new ones which mark a new era in human history. The industrial changes of the last forty or fifty years have been greater than those of all previous history. The development and distribution of technical information essential to such rapid progress has naturally been combined with much that seems mysterious and difficult for the uninitiated to understand.

It is the purpose of this discussion to place before the reader in elementary form and free from the difficult mathematical treatment it usually involves, one of the subjects on which much of our construction design depends.

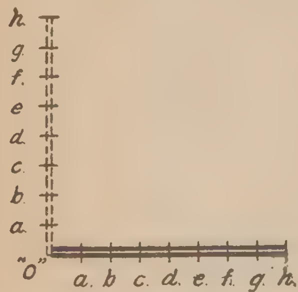


Figure (1)

Consider a steel bar eight feet long in a horizontal position shown in Figure 1, and assume that at each of the points, *a*, *b*, *c*, *d*, etc., there is one pound of material. If this bar is rotated to a vertical position as shown dotted, we know that work has been done. "*a*" has been lifted one foot and on it one foot pound of work was done. "*d*" has been lifted four feet and four foot pounds of work was done. "*h*" has been lifted eight feet and eight foot pounds of work was done. All of the work was done in the same time and we see at once, since the units each weighed a pound, there must have been a different force acting on each of them, and that this force must be proportional to the distance from the axis of rotation "O". That is, the force acting on "*a*" was one pound, on "*d*" four pounds, and on "*h*" eight pounds. In other words, the force representing the capacity of any body to resist being rotated about an axis is directly proportional to its distance from that axis. *Note clearly that this is not the moment of a force, but is the measure of the force itself.* The force acting on "*h*" is eight pounds, and since it is eight feet from the axis of rotation "O", the moment of the force will be 8 # × 8′ or 64′ #. This establishes that the moment of resistance to rotation about the axis "O" is proportional to the square of the distance from the axis. An understanding of this will enable us to remove the mystery from the so called fourth dimension and make it rational.

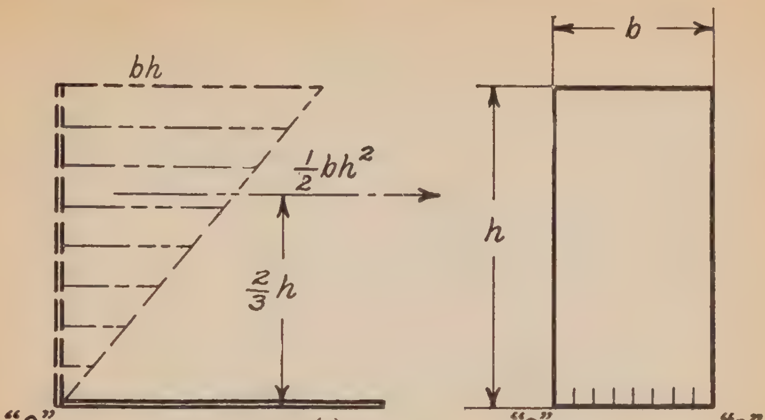


Figure (2)

If instead of a bar as in figure (1) we take several adjacent bars as shown in figure (2), we get a plate or rectangle whose height is h and whose breadth is b, and we again consider rotation about the axis O – O.

For each unit of breadth the force at a distance h from the axis will be h pounds and for b units of width the force is $b \times h$ pounds. This is represented graphically as bh in the figure (2). Similarly, the various horizontal lines in the triangle represent forces proportional to their distance from O and the area of the triangle will be the total of all the forces. The area of the triangle is $\frac{1}{2}$ $(bh \times h)$ $= \frac{1}{2}\ bh^2$. This force $\frac{1}{2}\ bh^2$ is the inertia of the rectangle whose height is h and breadth b when it is resisting rotation about the axis O – O. The force $\frac{1}{2}\ bh^2$ may be properly considered as concentrated at its center of gravity which is also the center of gravity of the triangle, and is $\frac{2}{3}\ h$ from the axis O – O.

The moment about the axis O – O of the force $\frac{1}{2}\ bh^2$ is $\frac{1}{2}\ bh^2 \times \frac{2}{3}\ h$, or $\frac{1}{3}\ bh^3$, and is a fourth dimension quantity since it is $\frac{1}{3}$ the area of the rectangle bh multiplied by the square of h the height of the rectangle.

The quantity $\frac{1}{3}\ bh^3$ is the moment of inertia of the rectangle about the axis O – O which is its base.

It is, however, usual in the analysis of stress in material that the rotation of a given cross section takes place about the center of gravity of the cross section instead of about its base O above found. This condition is shown in figure (3) where the axis of rotation is X – X. In such a case we have the equivalent of two rectangles each rotating about their base, and in which h of figure (2) becomes $h/2$. The moment of inertia in this case is therefore $2 \times \frac{1}{3}\ b\ (h/2)^3 = \frac{1}{12}\ bh^3$.

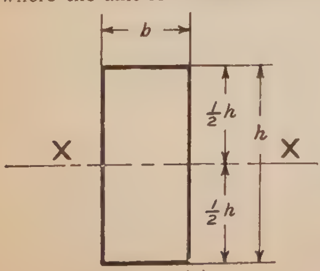


Figure (3)

The stresses which act in the materials of construction are classified as tension, compression or bearing, and shear. The action of pure tension is to elongate the material and reduce its area as it stretches. The action of compression is to shorten the specimen and

increase the area as it is compressed. The action of shear is to force the material on one side of a plane to slide along the material adjacent to it. One of the most familiar cases of shear is the punching of holes in a plate. Shear also exists in beams and girders, which also have tension and compression combined to form a couple to resist bending. It exists also in torsion where material is twisted as a shaft, and when a compression specimen is long enough shear acts along a plane at an angle to the axis of the specimen. Inasmuch as shear in the webs of beams and girders as well as in columns is combined with bearing or compression, the action is more properly described as one of crippling.

Consideration will now be given to the tension and compression stresses which form a couple to resist bending.

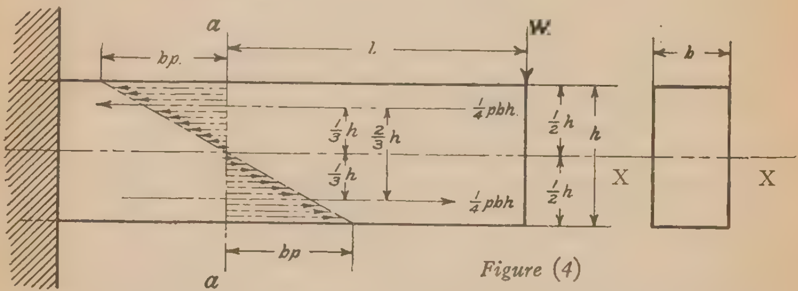


Figure (4)

Figure (4) represents a cantilever beam whose height is h and breadth b, and with a load W at a distance l from the cross section $a-a$. The maximum stress per square inch in tension or compression is p pounds.

The effect of the load W is to cause the section $a-a$ to rotate in the direction of a clock about the axis X–X. The only thing to prevent $a-a$ from rotating is the tension and compression stresses in the material. Above the center of the beam the fibres are in tension, and below the center they are in compression. The condition is similar to figure (3) and the intensity of the stresses will be directly proportional to their distance from the center. The maximum allowable intensity is, however, fixed as p pounds per square inch, and the total stress in the extreme fibre will be $b \times p$. The total stress for all fibres in tension or compression will be the area of the triangle, whose height is $h/2$ and whose breadth is bp.

This is $\frac{1}{2}\,bp \times h/2 = \frac{1}{4}\,bph$.

The effect of the tension and compression fibre stresses will be the same as if they were concentrated at the centers of gravity of the two triangles, and they will form a couple which balances the external bending moment. This balancing couple will therefore act opposite to the clock. The distance between the centers of gravity of the two triangles is $\frac{2}{3}\,h$ and the moment of the couple will be $\frac{1}{4}\,bph \times \frac{2}{3}h = \frac{1}{6}\,bph^2$ which is the moment of the internal stresses.

The moment of the external stresses M is $W \times l$.

From this we have the external moment $M = p \times \frac{1}{6}\,bh^2$.

In this we recognize the quantity $\frac{1}{6}\,bh^2$ as the section modulus of the rectangle bh, and the basic principle that the external moment M is equal to the stress per square inch in the extreme fibre multiplied by the section modulus (which is usually designated S.)

If we examine the value of the Section modulus we find that if it is multiplied by half the depth of the beam, or $h/2$ we get $\frac{1}{6} bh^2 \times h/2 = \frac{1}{12} bh^3$ which is the moment of inertia of the rectangle bh.

In other words, if we divide the moment of inertia by half the depth we get the section modulus, and the section modulus multiplied by the stress in the extreme fibre is the external moment.

In some text books half the depth $h/2$ is called y, and in others c, but as these are sometimes used in other connections in this discussion, v will indicate $h/2$.

Starting from the equation $M = p \times \frac{1}{6} bh^2$ and multiplying both sides by the same quantity, or rather the left side by v, and the right by $h/2$ we get $M \times v = p \times \frac{1}{6} bh^2 \times h/2 = p \times \frac{1}{12} bh^3$ or $Mv = pI$.

The fundamental principle involved in this elementrary discussion extends into almost every phase of construction, and a clear understanding of it will contribute much to the elimination of empirical solution, and to the establishing of rational analysis.

It has been the purpose in the foregoing discussion to present the subject in concrete practical form without complicating it with the development of general formulae. The rectangular cross-section has been used because it permits of the simplest mathematical analysis of a basic principle from which further development may proceed. While the design of structural steel seldom involves the use of a single rectangular cross section, it is usually possible to subdivide the section used into a number of rectangles or triangles, some of which will have to resist rotation about an axis which is neither at the base nor center of gravity of the rectangle. For this reason, it becomes necessary to have a formula for the moment of inertia of an area about an axis at a given distance from the center of gravity of the cross-section, and the development of this is given in connection with figure (5).

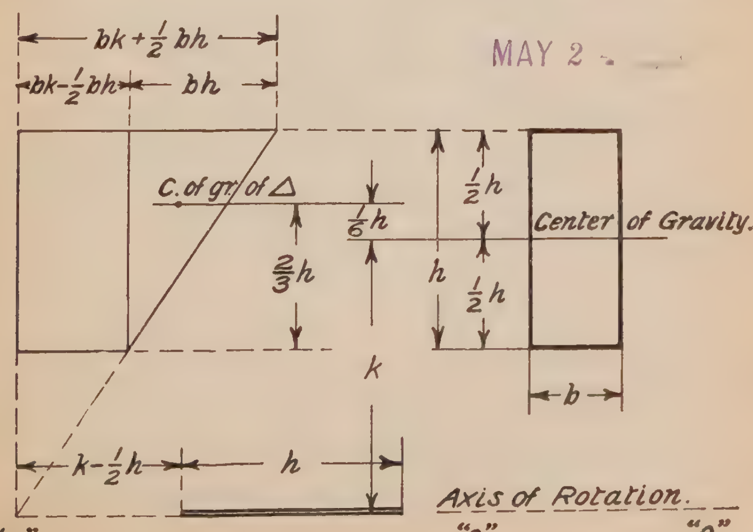


Figure (5)

This figure shows a rectangle with height h and breadth b rotating about an axis O - O which is a distance k from the center of gravity of the rectangle.

The distance from the axis O - O to the top of the rectangle is $k + h/2$ and from previous developed data the force for each unit of breadth is proportional to this distance, and therefore $k + h/2$. For b units of width, it will be b times this or $b\ (k + h/2) = bk + bh/2$. This is shown graphically in the diagram. Similarly the force for b units of width at the bottom of the rectangle or nearest the axis is $b\ k — bh/2$ which is also shown graphically. The total inertia or force resisting rotation about the axis O - O will be the area of the figure made up of the rectangle whose height is h, and breadth $bk—bh/2$ together with the triangle whose height is h and breadth $b\ h$. The center of gravity of the rectangle is a distance k from the axis, and that of the triangle a distance of $k + h/6$. The moment of inertia about the axis will be the areas of the rectangle and triangle multiplied by their respective distances. That is, the moment of inertia about axis O - O = area of rectangle $\times\ k$ + area of triangle $\times\ (k + h/6)$

$$= (b\ k — bh/2)\ h \times k + \tfrac{1}{2}\ b\ h^2\ (k + h/6)$$

$$= b\ h\ k^2 — bh^2k/2 + bh^2k/2 + \tfrac{1}{12}\ b\ h^3$$

$$= b\ h\ k^2 + \tfrac{1}{12}\ bh^3 = \text{Area} \times k^2 + \text{I}$$

Therefore, the moment of inertia of a rectangle about any axis is its moment of inertia about its center of gravity increased by the area of the rectangle multiplied by the square of the distance between the axis and the center of gravity.

In the analysis of the stresses in columns which fail by flexure the moment of inertia is used in a modified form which is called radius of gyration. The term "radius of gyration" is the distance from the axis of rotation at which, if the entire area were concentrated, it would have the same moment of inertia as the distributed area has. The formula for the moment of inertia of a rectangle about an axis through its center of gravity is

$$\text{I} = \tfrac{1}{12}\ bh^3 = bh \times \tfrac{1}{12}\ h^2$$

using A to equal the area $\qquad$ $\text{A} = b\ h$ and substituting

$$\text{I} = \text{A} \times \tfrac{1}{12}\ h^2 = \text{A}\ h^2/12 = \text{A}\ (h/\sqrt{12})^2$$

In this equation $h/\sqrt{12}$ is the distance from the center of gravity that the entire area must be concentrated to give the same moment of inertia as the distributed area and $h/\sqrt{12}$ is called the radius of gyration which is designated r

Substituting r for $h/\sqrt{12}$

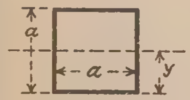
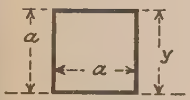
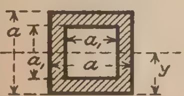
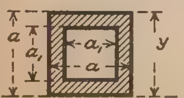
$\text{I} = \text{A}\ r^2$ or $r^2 = \text{I}/\text{A}$ and $r = \sqrt{\text{I}/\text{A}}$

Nomenclature

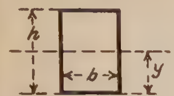
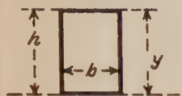
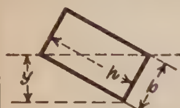
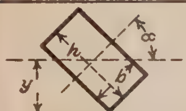
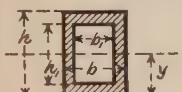
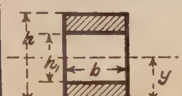
I	=	Moment of Inertia
S	=	Section Modulus
r	=	Radius of Gyration
h	=	height or depth
b	=	breadth
A	=	Area
X-X	=	Horizontal Axis
Y-Y	=	Vertical Axis
x	=	distance along Horizontal Axis
y	=	distance along Vertical Axis
W	=	Total Load
W, W_1, etc.	=	Concentrated Loads
R, R_1, etc.	=	Reactions at the Supports
M	=	Bending Moment
M^1	=	Negative Bending Moment
E	=	Modulus of Elasticity
V	=	Vertical Shear
D	=	Deflection

Any deviation from the above nomenclature is clearly noted at place of exception.

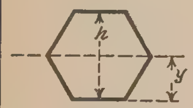
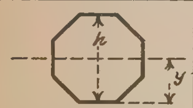
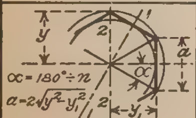
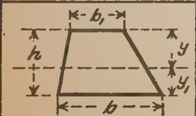
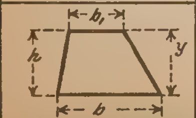
PROPERTIES OF VARIOUS SECTIONS

Section	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	a^2	$y = \frac{a}{2}$	$\frac{a^4}{12}$	$\frac{a^3}{6}$	$\frac{a}{\sqrt{12}} = .289\,a$
	a^2	$y = a$	$\frac{a^4}{3}$	$\frac{a^3}{3}$	$\frac{a}{\sqrt{3}} = .577\,a$
	a^2	$y = \frac{a}{\sqrt{2}} = .707\,a$	$\frac{a^4}{12}$	$\frac{a^3}{6\sqrt{2}} = .118\,a^3$	$\frac{a}{\sqrt{12}} = .289\,a$
	$a^2 - a_1^2$	$y = \frac{a}{2}$	$\frac{a^4 - a_1^4}{12}$	$\frac{a^4 - a_1^4}{6\,a}$	$\sqrt{\frac{a^2 + a_1^2}{12}}$
	$a^2 - a_1^2$	$y = a$	$\frac{a^4 - a_1^4}{3}$	$\frac{a^4 - a_1^4}{3\,a}$	$\sqrt{\frac{a^2 + a_1^2}{3}}$
	$a^2 - a_1^2$	$y = \frac{a}{\sqrt{2}} = .707\,a$	$\frac{a^4 - a_1^4}{12}$	$\frac{(a^4 - a_1^4)\sqrt{2}}{12\,a} = .118\,\frac{a^4 - a_1^4}{a}$	$\sqrt{\frac{a^2 + a_1^2}{12}} = .289\sqrt{a^2 + a_1^2}$

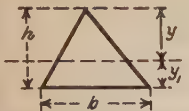
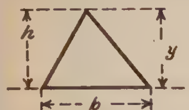
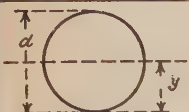
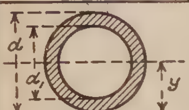
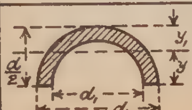
PROPERTIES OF VARIOUS SECTIONS

Sections	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	bh	$y = \frac{h}{2}$	$\frac{bh^3}{12}$	$\frac{bh^2}{6}$	$\frac{h}{\sqrt{12}} = .289\ h$
	bh	$y = h$	$\frac{bh^3}{3}$	$\frac{bh^2}{3}$	$\frac{h}{\sqrt{3}} = .577\ h$
	bh	$y = \frac{bh}{\sqrt{b^2 + h^2}}$	$\frac{b^3h^3}{6\,(b^2 + h^2)}$	$\frac{b^2h^2}{6\sqrt{b^2 + h^2}}$	$\frac{bh}{\sqrt{6\,(b^2 + h^2)}}$
	bh	$y = \frac{h \cos \alpha + b \sin \alpha}{2}$	$\frac{bh}{12}\left(h^2 \cos^2\alpha + b^2 \sin^2\alpha\right)$	$\frac{bh}{6}\left(\frac{h^2 \cos^2 \alpha + b^2 \sin^2 \alpha}{h \cos \alpha + b \sin \alpha}\right)$	$\sqrt{\frac{h^2 \cos^2 \alpha + b^2 \sin^2 \alpha}{12}}$
	$bh - b_1 h_1$	$y = \frac{h}{2}$	$\frac{bh^3 - b_1 h_1^3}{12}$	$\frac{bh^3 - b_1 h_1^3}{6h}$	$\sqrt{\frac{bh^3 - b_1 h_1^3}{12\,(bh - b_1 h_1)}}$
	$b\,(h - h_1)$	$y = \frac{h}{2}$	$\frac{b\,(h^3 - h_1^3)}{12}$	$\frac{b\,(h^3 - h_1^3)}{6h}$	$\sqrt{\frac{h^3 - h_1^3}{12\,(h - h_1)}}$

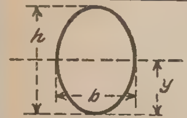
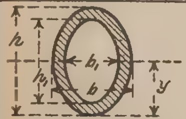
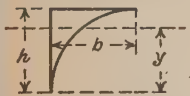
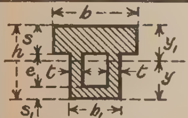
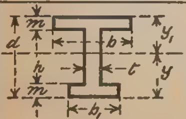
PROPERTIES OF VARIOUS SECTIONS

Sections	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	$\frac{3}{2} h^2 \tan. 30° = .866\, h^2$	$y = \frac{h}{2}$	$\frac{A}{12}\left[\frac{h^2(1+2\cos^2 30°)}{4\cos^2 30°}\right]$ $= .06\, h^4$	$\frac{A}{6}\left[\frac{h(1+2\cos^2 30°)}{4\cos^2 30°}\right]$ $= .12\, h^3$	$\frac{h}{4\cos 30°}\sqrt{\frac{1+2\cos^2 30°}{3}}$ $= .264\, h$
	$\frac{3}{2} h^2 \tan. 30° = .866\, h^2$	$y = \frac{h}{2\cos 30°} = .577\, h$	$\frac{A}{12}\left[\frac{h^2(1+2\cos^2 30°)}{4\cos^2 30°}\right]$ $= .06\, h^4$	$\frac{A}{6}\left[\frac{h(1+2\cos^2 30°)}{4\cos 30°}\right]$ $= .104\, h^3$	$\frac{h}{4\cos 30°}\sqrt{\frac{1+2\cos^2 30°}{3}}$ $= .264\, h$
	$2 h^2 \tan. 22\tfrac{1}{2}° = .828\, h^2$	$y = \frac{h}{2}$	$\frac{A}{12}\left[\frac{h^2(1+2\cos^2 22\frac{1}{2}°)}{4\cos^2 22\frac{1}{2}°}\right]$ $= .055\, h^4$	$\frac{A}{6}\left[\frac{h(1+2\cos^2 22\frac{1}{2}°)}{4\cos 22\frac{1}{2}°}\right]$ $= .109\, h^3$	$\frac{h}{4\cos 22\frac{1}{2}°}\sqrt{\frac{1+2\cos^2 22\frac{1}{2}°}{3}}$ $= .257\, h$
	n = Number of Sides $A = \tfrac{1}{4} na^2 \cot. \alpha$ $= \tfrac{1}{2} ny^2 \sin. 2\alpha$ $= ny_1^2 \tan. \alpha$	$y = \frac{a}{2\sin. \alpha}$ $y_1 = \frac{a}{2\tan. \alpha}$	$I_{1-1} = \frac{A(6y^2 - a^2)}{24}$ $I_{2-2} = \frac{A(12y_1^2 + a^2)}{48}$	$S_{1-1} = \frac{A(6y^2 - a^2)}{24\, y}$ $S_{2-2} = \frac{A(12 y_1^2 + a^2)}{48\, y_1}$	$r_{1-1} = \sqrt{\frac{6y^2 - a^2}{24}}$ $r_{2-2} = \sqrt{\frac{12 y_1^2 + a^2}{48}}$
	$\frac{h(b+b_1)}{2}$	$y = \frac{h(b_1+2b)}{3(b_1+b)}$ $y_1 = \frac{h(b+2b_1)}{3(b+b_1)}$	$\frac{h^3(b^2+4bb_1+b_1^2)}{36(b+b_1)}$	$\frac{h^2(b^2+4bb_1+b_1^2)}{12(b_1+2b)}$	$\frac{h}{6(b+b_1)}\sqrt{2(b^2+4bb_1+b_1^2)}$
	$\frac{h(b+b_1)}{2}$	$y = h$	$\frac{h^3(b+3b_1)}{12}$	$\frac{h^2(b+3b_1)}{12}$	$\frac{h}{\sqrt{6}}\sqrt{\frac{b+3b_1}{b+b_1}}$

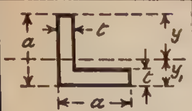
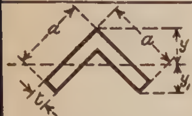
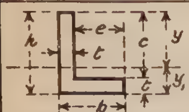
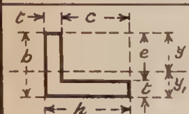
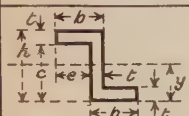
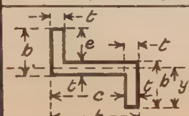
PROPERTIES OF VARIOUS SECTIONS

Sections	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	$\frac{bh}{2}$	$y = \frac{2h}{3}$ $y_1 = \frac{h}{3}$	$\frac{bh^3}{36}$	$\frac{bh^2}{24}$	$\frac{h}{\sqrt{18}} = .235702\ h$
	$\frac{bh}{2}$	$y = h$	$\frac{bh^3}{12}$	$\frac{bh^2}{12}$	$\frac{h}{\sqrt{6}} = .408248\ h$
	$\frac{\pi d^2}{4} = .785398\ d^2$	$y = \frac{d}{2}$	$\frac{\pi d^4}{64} = .049087\ d^4$	$\frac{\pi d^3}{32} = .098175\ d^3$	$\frac{d}{4}$
	$\frac{\pi (d^2 - d_1^2)}{4}$ $= .785398\ (d^2 - d_1^2)$	$y = \frac{d}{2}$	$\frac{\pi (d^4 - d_1^4)}{64} = .049087\ (d^4 - d_1^4)$	$\frac{\pi (d^4 - d_1^4)}{32\ d}$ $= .098175\ \frac{d^4 - d_1^4}{d}$	$\frac{\sqrt{d^2 + d_1^2}}{4}$
	$\frac{\pi d^2}{8} = .392699\ d^2$	$y = \frac{d\ (3\pi - 4)}{6\pi} = .287793\ d$ $y_1 = \frac{2d}{3\pi} = .212207\ d$	$\frac{d^4\ (9\pi^2 - 64)}{1152\ \pi} = .006860\ d^4$	$\frac{d^3\ (9\pi^2 - 64)}{192\ (3\pi - 4)}$ $= .023836\ d^3$	$\frac{d\ \sqrt{9\pi^2 - 64}}{12\ \pi}$ $= .132168\ d$
	$\frac{\pi (d^2 - d_1^2)}{8}$ $= .392699\ (d^2 - d_1^2)$	$y = \frac{2\ (d^3 - d_1^3)}{3\pi\ (d^2 - d_1^2)}$ $y_1 = \frac{3\pi d\ (d^2 - d_1^2) - 4\ (d^3 - d_1^3)}{6\pi (d^2 - d_1^2)}$	$\frac{9\pi^2 (d^4 - d_1^4)(d^2 - d_1^2) - 64\ (d^3 - d_1^3)^2}{1152\ \pi\ (d^2 - d_1^2)}$	$\frac{I}{y}$ if $y > y_1$ $\frac{I}{y_1}$ if $y_1 > y$	$\sqrt{\frac{I}{A}}$

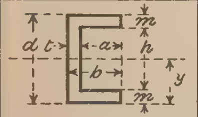
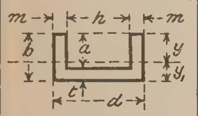
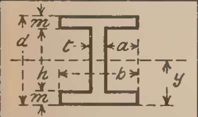
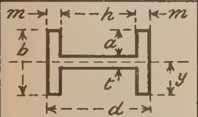
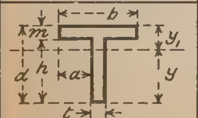
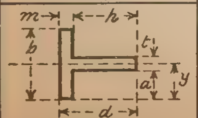
PROPERTIES OF VARIOUS SECTIONS

Sections	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	$\frac{\pi\, bh}{4} = .785\, bh$	$\frac{h}{2}$	$\frac{\pi\, bh^3}{64} = .049\, bh^3$	$\frac{\pi\, bh^2}{32} = .098\, bh^2$	$\frac{h}{4}$
	$\frac{\pi(bh - b_1h_1)}{4}$ $= .785\,(bh - b_1h_1)$	$\frac{h}{2}$	$\frac{\pi\,(bh^3 - b_1h_1^3)}{64}$ $= .049\,(bh^3 - b_1h_1^3)$	$\frac{\pi\,(bh^3 - b_1h_1^3)}{32\,h}$ $= \frac{.098\,(bh^3 - b_1h_1^3)}{h}$	$\frac{1}{4}\sqrt{\frac{bh^3 - b_1h_1^3}{bh - b_1h_1}}$
	$(b = h = r)$ $r^2 - \frac{\pi\, r^2}{4}$ $= .2146\, r^2$	$\frac{r}{6\left(1 - \frac{\pi}{4}\right)}$ $= .7767\, r$	$r^4\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36 - 9\,\pi}\right)$ $= .0075\, r^4$	$\frac{I}{y}$ $= .00966\, r^3$	$\sqrt{.03494\, r^2}$ $= .18693\, r$
	$bs + 2\,et + b_1s_1$	$y = \frac{2th^2 + (b_1 - 2t)\,s_1^2 + (b - 2t)\,(2h - s)\,s}{2\,A}$ $y_1 = h - y$	$\frac{b_1y^3 + by_1^3 - (b_1 - 2t)\,(y - s_1)^3}{3} - \frac{(b - 2t)\,(y_1 - s)^3}{3}$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$bm + ht + b_1m$	$y = d - y_1$ $y_1 = \frac{td^2 + m^2\,(b - t) + m\,(b_1 - t)\,(2d - m)}{2\,A}$	$\frac{by_1^3 + b_1y^3 - (b - t)\,(y_1 - m)^3}{3} - \frac{(b_1 - t)\,(y - m)^3}{3}$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$td + s\,(b - t)$	$\frac{d}{2}$	$\frac{td^3 + s^3\,(b - t)}{12}$	$\frac{td^3 + s^3\,(b - t)}{6\,d}$	$\sqrt{\frac{td^3 + s^3\,(b - t)}{12\,[td + s\,(b - t)]}}$

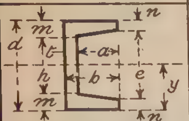
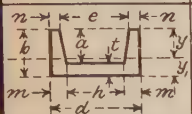
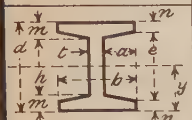
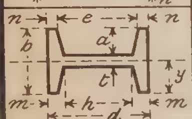
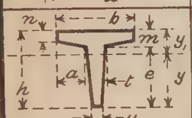
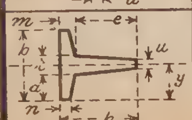
PROPERTIES OF VARIOUS SECTIONS

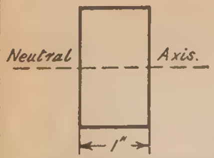
Sections	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	$t(2a-t)$	$y = a - \frac{a^2 + at - t^2}{2(2a-t)}$ $y_1 = \frac{a^2 + at - t^2}{2(2a-t)}$	$\frac{1}{3}\left[ty^3 + a(a-y)^3 - (a-t)(a-y-t)^3\right]$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$t(2a-t)$	$y = \frac{a^2 + at - t^2}{2(2a-t)\cos 45°}$ $y_1 = \sin 45°(a+t) - y$ $= .70711(a+t) - y$	When $x = a^2 + at - t^2 \div 2(2a-t)$ $\frac{1}{3}\left[2x^4 - 2(x-t)^4 + t\left[a - \left(2x - \frac{t}{2}\right)\right]^3\right]$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$t(b+h-t)$	$y = h - \frac{t(b+2c) + c^2}{2(b+c)}$ $y_1 = \frac{t(b+2c) + c^2}{2(b+c)}$	$\frac{1}{3}\left[t(h-y_1)^3 + by_1^3 - e(y_1-t)^3\right]$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$t(b+h-t)$	$y = h - \frac{t(h+2e) + e^2}{2(h+e)}$ $y_1 = \frac{t(h+2e) + e^2}{2(h+e)}$	$\frac{1}{3}\left[t(b-y_1)^3 + hy_1^3 - c(y_1-t)^3\right]$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$t(h+2e)$	$y = \frac{h}{2}$	$\frac{1}{12}\left[bh^3 - e(h-2t)^3\right]$	$\frac{bh^3 - e(h-2t)^3}{6h}$	$\sqrt{\frac{bh^3 - e(h-2t)^3}{12t(h+2e)}}$
	$t(h+2e)$	$y = \frac{2b-t}{2}$	$\frac{1}{12}\left[h(b+e)^3 - 2e^3c - 6eb^2c\right]$	$\frac{h(b+e)^3 - 2e^3c - 6eb^2c}{6(2b-t)}$	$\sqrt{\frac{h(b+e)^3 - 2e^3c - 6eb^2c}{6(2b-t)}}$

PROPERTIES OF VARIOUS SECTIONS

Sections	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	$bd - ah$	$y = \frac{d}{2}$	$\frac{1}{12}(bd^3 - ah^3)$	$\frac{bd^3 - ah^3}{6d}$	$\sqrt{\frac{bd^3 - ah^3}{12(bd - ah)}}$
	$bd - ah$	$y = b - y_1$ $y_1 = \frac{2b^2m + ht^2}{2A}$	$\frac{1}{3}(2mb^3 + ht^3) - Ay_1^2$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$bd - 2ah$	$y = \frac{d}{2}$	$\frac{1}{12}(bd^3 - 2ah^3)$	$\frac{bd^3 - 2ah^3}{6d}$	$\sqrt{\frac{I}{A}}$
	$bd - 2ah$	$y = \frac{b}{2}$	$\frac{1}{12}(2mb^3 + ht^3)$	$\frac{2mb^3 + ht^3}{6b}$	$\sqrt{\frac{I}{A}}$
	$bm + ht$	$y = d - y_1$ $y_1 = \frac{d^2t + m^2(b - t)}{2A}$	$\frac{1}{3}\left(ty^3 + by_1^3 - 2a(y_1 - m)^3\right)$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$bm + ht$	$y = \frac{b}{2}$	$\frac{1}{12}(mb^3 + ht^3)$	$\frac{mb^3 + ht^3}{6b}$	$\sqrt{\frac{I}{A}}$

PROPERTIES OF VARIOUS SECTIONS

Sections	Area of Section A	Distance from Axis to Extremities of Section y and y_1	Moment of Inertia I	Section Modulus $S = \frac{I}{y}$	Radius of Gyration $r = \sqrt{\frac{I}{A}}$
	$td + a(m + n)$	$y = \frac{d}{2}$	$\frac{1}{12}\left[bd^3 - \frac{a}{8(m-n)}(e^4 - h^4)\right]$	$\frac{2I}{d}$	$\sqrt{\frac{I}{A}}$
	$td + a(m + n)$	$y = b - y_1$ $y_1 = \frac{b^2n + \frac{et^2}{2} + \frac{a(m-n)}{3}(b + 2t)}{A}$	$\frac{1}{3}\left[2nb^3 + ht^3 + \frac{m-n}{2a}(b^4 - t^4)\right] - Ay_1^2$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$td + 2a(m + n)$	$y = \frac{d}{2}$	$\frac{1}{12}\left[bd^3 - \frac{a}{4(m-n)}(e^4 - h^4)\right]$	$\frac{2I}{d}$	$\sqrt{\frac{I}{A}}$
	$td + 2a(m + n)$	$y = \frac{b}{2}$	$\frac{1}{12}\left[2nb^3 + ht^3 + \frac{m-n}{4a}(b^4 - t^4)\right]$	$\frac{2I}{b}$	$\sqrt{\frac{I}{A}}$
	$\frac{e(t+u)}{2} + tm + a(m + n)$	$y = h - y_1$ $y_1 = [6an^2 + 2a(m-n)(m+2n) + 3td^2 - e(t-u)(3d-e)] \div 6A$	$\frac{1}{12}\left[e^3(3u+t) + 4bm^3 - 2a(m-n)^3\right] - A(y_1 - m)^2$	$\frac{I}{y}$	$\sqrt{\frac{I}{A}}$
	$\frac{e(t+u)}{2} + tm + a(m + n)$	$y = \frac{b}{2}$	$\frac{nb^3 + (m-n)t^3 + eu^3}{12} + \frac{a(m-n)[2a^2 + (2a+3t)^2]}{36} + \frac{e(t-u)[(t-u)^2 + 2(t+2u)]}{144}$	$\frac{2I}{b}$	$\sqrt{\frac{I}{A}}$



MOMENTS OF INERTIA OF RECTANGLES

ABOUT THE NEUTRAL AXIS

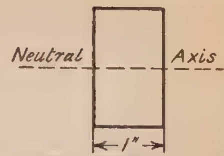
Values given are the Moments of Inertia for Rectangles
ONE INCH WIDE

The value for any width rectangle may be obtained from
value given by direct multiplication

h in Inches	Additional Height h.							
	0	1/16 .0625	1/8 .125	3/16 .1875	1/4 .250	5/16 .3125	3/8 .375	7/16 .4375
0	......	.00002	.00016	.00055	00130	.00254	00439	.00698
1	08333	.09995	.11865	13955	16276	.18842	.21663	.24754
2	.66667	73114	.79964	.87229	.94922	1.0305	1.1164	1.2068
3	2.2500	2.3936	2.5431	2.6988	2.8607	3 0289	3.2036	3.3849
4	5.3333	5.5873	5.8491	6.1190	6.3971	6.6002	6.9783	7.2817
5	10.417	10.812	11.218	11.633	12.059	12.494	12.941	13.397
6	18.000	18.568	19.149	19.741	20.345	20.961	21.590	22.232
7	28.583	29.356	30.142	30.942	31.757	32.585	33.428	34.285
8	42.667	43.674	44.698	45.737	46.793	47.864	48.952	50.056
9	60.750	62.024	63.317	64.626	65.954	67.300	68.665	70.047
10	83.333	84.906	86.498	88.109	89.741	91.392	93.064	94.756
11	110.92	112.82	114.74	116.69	118.65	120.64	122.65	124.68
12	144.00	146.26	148.55	150.86	153.19	155.55	157.93	160.33
13	183.08	185.74	188.42	191.12	193.85	196.61	199.39	202.20
14	228.67	231.74	234.85	237 98	241.14	244.32	247.54	250.78
15	281.25	284.78	288.34	291.93	295.55	299.20	302.87	306.58
16	341.33	345.35	349.40	353.47	357.58	361.73	365.90	370.11
17	409.42	413.95	418.52	423.11	427.75	432.41	437.11	441.85
18	486.00	491.41	496.20	501.35	506.53	511.75	517.01	522.31
19	571.58	577.24	582.94	588.67	594.44	600.25	606.10	611.98
20	666.67	672.94	679.24	685.59	691.84	698.41	704.87	711.38
21	771.75	778.66	785.61	792.61	799 65	806.72	813.84	821.00
22	887.33	894.92	902.54	910.21	917.93	925.68	933.49	941.33
23	1013.9	1022.2	1030.5	1038.9	1047.3	1055.8	1064.3	1072.9
24	1152.0	1161.0	1170.1	1178.4	1188.4	1197.6	1206.8	1216.2
25	1302.1	1311.9	1321.7	1331.6	1341.5	1351.5	1361.6	1371.6
26	1464.7	1475.3	1485.9	1496.6	1507.3	1518.1	1529.0	1539.9
27	1640.2	1651.7	1663.1	1674.7	1686.2	1697.9	1709.5	1721.3
28	1829.3	1841.6	1853.9	1866.3	1878.8	1891.3	1903.8	1916.4
29	2032.4	2045.6	2058.8	2072.1	2085.4	2098.8	2112.3	2125.8
30	2250.0	2264.1	2278.2	2292.4	2306.7	2321.0	2335.4	2349.9
31	2482.6	2497 6	2512.7	2527.9	2543.1	2558.4	2573.8	2589.2
32	2730.7	2746.7	2762.8	2778.9	2795.2	2811.4	2827.8	2844.2
33	2994.7	3011.8	3028.9	3046.1	3063.3	3080.4	3098.0	3115.4
34	3275.3	3293.4	3311.6	3329.8	3348.1	3366.5	3384.9	3403.4
35	3572.9	3592.0	3611.3	3630.6	3650.0	3669.5	3689.0	3708.6
36	3888.0	3908.3	3928.6	3949.1	3969.6	3990.1	4010.8	4031.5
37	4221.1	4242.5	4264.0	4285.6	4307.3	4328.9	4350.7	4372.6
38	4572.7	4595.3	4617.9	4640.7	4663.5	4686.4	4719.4	4732.4
39	4943.3	4967 0	4990.9	5014.9	5038.9	5063.0	5087.2	5111.5
40	5333.3	5358 4	5383.5	5408.7	5433.9	5459.3	5484.7	5510.2
41	5743.4	5769.7	5796.1	5822.6	5849.1	5875.7	5902.5	5929.2
42	6174.0	6201.6	6229.3	6257.1	6284.9	6312.8	6340.9	6368.9
43	6625.6	6654.5	6683.5	6703.5	6741.8	6771.1	6800.4	6829.9
44	7098.7	7129.0	7159.3	7189.0	7220.3	7251.0	7281 7	7312.5
45	7593.8	7625.4	7657.2	7689.1	7721.0	7753.0	7785 2	7817.4
46	8111.3	8144.7	8177.6	8210.9	8444.3	8277.8	8311.3	8345.0
47	8651.9	8686.5	8721.1	8755.9	8790.7	8825.6	8860.7	8895.8
48	9216.0	9252.0	9288.2	9324.4	9360.7	9397.2	9433 7	9470.3
49	9804.1	9841.6	9879.3	9833 7	9954.9	9992 9	10031	10071
50	10417	10456	10495	10534	10574	10613	10653	10692
51	11054	11095	11136	11177	11218	11259	11300	11341
52	11717	11760	11802	11845	11887	11930	11973	12016
53	12406	12450	12494	12539	12583	12627	12672	12716
54	13122	13168	13213	13259	13305	13351	13397	13444
55	13865	13912	13959	14007	14055	14102	14150	14198
56	14635	14684	14733	14782	14832	14881	14931	14980
57	15433	15484	15535	15586	15637	15688	15739	15791
58	16259	16312	16365	16418	16470	16524	16577	16630
59	17115	17169	17224	17279	17333	17388	17443	17498

MOMENTS OF INERTIA OF RECTANGLES

ABOUT THE NEUTRAL AXIS

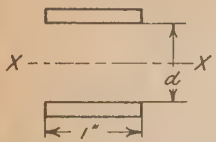


Values given are the Moments of Inertia for Rectangles
ONE INCH WIDE

The value for any width rectangle may be obtained from value given by direct multiplication

h in Inches	Additional Height *h*.							
	½ .500	9/16 .5625	5/8 .625	11/16 .6875	¾ .750	13/16 .8125	7/8 .875	15/16 .9375
0	.01041	.01483	.02034	.02708	.03516	.04469	.05583	.06866
1	.28125	.31789	.35758	.40045	.44661	.49620	.54932	.60610
2	1.3021	1.4022	1.5073	1.6176	1.7331	1.8539	1.9803	2.1123
3	3.5729	3.7678	3.9696	4.1784	4.3945	4.6179	4.8488	5.0872
4	7.5937	7.9146	8.2443	8.5831	8.9310	9.2882	9.6548	10.031
5	13.865	14.343	14.832	15.331	15.843	16.365	16.898	17.443
6	22.885	23.552	24.231	24.924	25.629	26.347	27.079	27.825
7	35.156	36.043	36.944	37.859	38.790	39.736	40.698	41.674
8	51.177	52.314	53.468	54.639	55.827	57.032	58.254	59.493
9	71.448	72.867	74.305	75.762	77.238	78.733	80.247	81.780
10	96.469	98.202	99.955	101.73	103.52	105.34	107.18	109.04
11	126.74	128.82	130.92	133.04	135.19	137.35	139.55	141.76
12	162.76	165.21	167.69	170.19	172.72	175.28	177.85	180.46
13	205.03	207.89	210.78	213.69	216.63	219.60	222.60	225.62
14	254.05	257.35	260.68	264.04	267.42	270.83	274.28	277.75
15	310.32	314.09	317.89	321.72	325.58	329.47	333.40	337.35
16	374.34	378.61	382.92	387.25	391.62	396.02	400.45	404.92
17	446.61	451.42	456.25	461.12	466.03	470.97	475.94	480.95
18	527.63	533.00	538.40	543.84	549.32	554.83	560.38	565.96
19	617.91	623.87	629.87	635.90	641.98	648.09	654.24	660.44
20	717.93	724.51	731.14	737.81	744.51	751.26	758.05	764.88
21	828.20	835.44	842.73	850.05	857.43	864.84	872.29	879.79
22	949.22	957.15	965.13	973.15	981.21	989.32	997.47	1005.7
23	1081.5	1090.1	1098.8	1107.6	1116.4	1225.2	1134.1	1143.0
24	1225.5	1234.9	1244.4	1253.9	1263.4	1273.0	1282.6	1292.3
25	1381.8	1392.0	1402.2	1412.5	1422.8	1433.2	1443.6	1454.1
26	1550.8	1561.8	1572.8	1584.0	1595.1	1606.3	1617.6	1628.9
27	1733.1	1744.9	1756.8	1768.8	1780.8	1792.8	1804.9	1817.1
28	1929.1	1941.8	1954.6	1967.4	1980.3	1993.2	2006.2	2019.3
29	2139.4	2153.0	2166.7	2180.4	2194.2	2208.1	2222.0	2236.0
30	2364.4	2378.9	2393.6	2408.3	2423.0	2437.8	2452.7	2467.6
31	2604.7	2620.2	2635.8	2651.4	2667.2	2682.9	2698.8	2714.7
32	2860.7	2877.2	2893.8	2910.5	2927.2	2944.0	2960.8	2977.8
33	3132.9	3150.5	3168.1	3185.8	3203.6	3221.4	3239.3	3257.3
34	3422.0	3440.6	3459.3	3478.1	3496.9	3515.8	3534.8	3553.8
35	3728.2	3748.0	3767.8	3787.6	3807.6	3827.6	3847.6	3867.8
36	4052.3	4073.1	4094.0	4115.0	4136.1	4157.2	4178.4	4199.7
37	4394.5	4416.5	4438.6	4460.8	4483.0	4505 3	4527.7	4550.1
38	4755.5	4778.7	4802.0	4825.4	4848.8	4872.3	4895.9	4919.5
39	5135.8	5160.2	5184.7	5209.3	5239.6	5285.3	5283.5	5308.4
40	5535.8	5561.5	5587.3	5613.1	5639.0	5665.0	5691.0	5717.2
41	5956.1	5983.1	6010.1	6037.0	6064.4	6091.7	6119.0	6146.5
42	6397.1	6425.4	6453.7	6482.2	6510.7	6539.3	6568.0	6596.7
43	6867.7	6889.0	6918.7	6948.5	6978.3	7008.3	7038.3	7068.5
44	7343.4	7374.4	7405.5	7436.6	7467.9	7499.2	7530.6	7562.1
45	7849.7	7882.1	7914.6	7947.1	7979.8	8012.5	8045.4	8078.3
46	8378.7	8412.5	8466.5	8480.5	8514.6	8548.8	8583.1	8617.4
47	8931.0	8966.3	9001.7	9037.2	9072.7	9108.4	9144.2	9180.0
48	9507.0	9544.1	9580.7	9617 7	9654.8	9692.0	9729 2	9766.6
49	10107	10146	10184	10223	10261	10300	10339	10378
50	10732	10772	10812	10852	10892	10933	10973	11014
51	11383	11424	11466	11507	11549	11591	11633	11675
52	12059	12102	12145	12188	12232	12275	12319	12363
53	12761	12806	12851	12896	12941	12986	13031	13076
54	13490	13536	13583	13630	13676	13723	13770	13817
55	14246	14294	14343	14391	14440	14488	14537	14586
56	15030	15080	15130	15180	15231	15281	15331	15382
57	15842	15894	15946	15998	16050	16102	16154	16207
58	16683	16737	16791	16844	16898	16952	17006	17061
59	17554	17609	17665	17720	17776	17832	17888	17944

MOMENTS OF INERTIA OF TWO PLATES



Moments of Inertia of Two Plates

ONE INCH WIDE

About Axis X — X

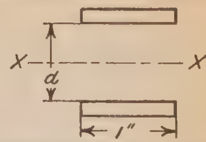
Distances Measured from Inside to Inside

For Moments of Inertia, deducting for rivet holes, multiply tabular value by net width.

d Ins.	Thickness of Plates in Inches.													
	1/8	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
5	1.6	3.4	4.4	5.4	6.5	7.6	8.7	9.9	11.2	12.5	13.8	15.2	16.6	18.2
5¼	1.8	3.8	4.8	5.9	7.1	8.3	9.5	10.8	12.2	13.6	15.0	16.5	18.1	19.7
5½	2.0	4.1	5.3	6.5	7.7	9.0	10.4	11.8	13.2	14.7	16.3	17.9	19.6	21.3
5¾	2.2	4.5	5.7	7.0	8.4	9.8	11.2	12.7	14.3	15.9	17.6	19.3	21.1	22.9
6	2.3	4.9	6.2	7.6	9.1	10.6	12.1	13.8	15.4	17.2	18.9	20.7	22.7	24.7
6¼	2.5	5.3	6.7	8.2	9.8	11.4	13.1	14.8	16.6	18.5	20.4	22.3	24.4	26.5
6½	2.7	5.7	7.3	8.9	10.5	12.3	14.1	15.9	17.8	19.8	21.8	23.9	26.1	28.3
6¾	3.0	6.1	7.8	9.5	11.3	13.2	15.1	17.0	19.1	21.2	23.3	25.5	27.8	30.2
7	3.2	6.6	8.4	10.2	12.1	14.1	16.1	18.2	20.4	22.6	24.9	27.2	29.7	32.2
7¼	3.4	7.0	8.9	10.9	12.9	15.0	17.2	19.4	21.7	24.1	26.5	29.0	31.6	34.2
7½	3.6	7.5	9.5	11.6	13.8	16.0	18.3	20.7	23.1	25.6	28.2	30.8	33.5	36.3
7¾	3.9	8.0	10.2	12.4	14.7	17.0	19.5	22.0	24.5	27.2	29.9	32.7	35.5	38.4
8	4.1	8.5	10.8	13.2	15.6	18.1	20.6	23.3	26.0	28.8	31.6	34.6	37.6	40.7
8¼	4.4	9.0	11.5	14.0	16.5	19.2	21.9	24.7	27.5	30.5	33.5	36.5	39.7	43.0
8½	4.6	9.6	12.1	14.8	17.5	20.3	23.1	26.1	29.1	32.2	35.3	38.6	41.9	45.3
8¾	4.9	10.1	12.8	15.6	18.5	21.4	24.4	27.5	30.7	33.9	37.2	40.6	44.1	47.7
9	5.2	10.7	13.6	16.5	19.5	22.6	25.7	29.0	32.3	35.7	39.2	42.8	46.4	50.2
9¼	5.5	11.3	14.3	17.4	20.5	23.8	27.1	30.5	34.0	37.6	41.2	45.0	48.8	52.7
9½	5.8	11.9	15.0	18.3	21.6	25.0	28.5	32.1	35.7	39.5	43.3	47.2	51.2	55.3
9¾	6.1	12.5	15.8	19.2	22.7	26.3	29.9	33.7	37.5	41.4	45.4	49.5	53.7	57.9
10	6.4	13.1	16.6	20.2	23.8	27.6	31.4	35.3	39.3	43.4	47.6	51.9	56.2	60.7
10¼	6.7	13.8	17.4	21.2	25.0	28.9	32.9	37.0	41.2	45.5	49.8	54.3	58.8	63.5
10½	7.1	14.5	18.3	22.2	26.2	30.3	34.5	38.7	43.1	47.5	52.1	56.7	61.5	66.3
10¾	7.4	15.1	19.1	23.2	27.4	31.7	36.0	40.5	45.0	49.7	54.4	59.2	64.2	69.2
11	7.7	15.8	20.0	24.3	28.6	33.1	37.6	42.3	47.0	51.9	56.8	61.8	66.9	72.2
11¼	8.1	16.5	20.9	25.4	29.9	34.5	39.3	44.1	49.0	54.1	59.2	64.4	69.8	75.2
11½	8.4	17.3	21.8	26.5	31.2	36.0	40.9	46.0	51.1	56.4	61.7	67.1	72.7	78.3
11¾	8.8	18.0	22.7	27.6	32.5	37.5	42.7	47.9	53.2	58.7	64.2	69.8	75.6	81.4
12	9.2	18.8	23.7	28.7	33.9	39.1	44.2	49.8	55.4	61.0	66.8	72.6	76.8	84.7
12¼	9.6	19.5	24.7	29.9	35.2	40.7	46.2	51.8	57.6	63.5	69.4	75.5	81.7	88.0
12½	10.0	20.3	25.7	31.1	36.6	42.3	48.0	53.9	59.8	65.9	72.1	78.4	84.8	91.3
12¾	10.4	21.1	26.7	32.3	38.1	43.9	49.9	55.9	62.1	68.4	74.8	81.3	88.0	94.7
13	10.8	21.9	27.7	33.6	39.5	45.6	51.8	58.1	64.5	71.0	77.6	84.3	91.2	98.2
13¼	11.2	22.8	28.8	34.8	41.0	47.3	53.7	60.2	66.8	73.6	80.4	87.4	94.5	101.7
13½	11.6	23.6	29.8	36.1	42.5	49.0	55.6	62.4	69.3	76.2	83.3	90.5	97.8	105.3
13¾	12.0	24.5	30.9	37.4	44.0	50.8	57.6	64.6	71.7	78.9	86.2	93.7	101.3	108.9
14	12.5	25.4	32.0	38.8	45.6	52.6	59.7	66.9	74.2	81.7	89.2	96.9	104.7	112.7
14¼	12.9	26.3	33.1	40.1	47.2	54.4	61.7	69.2	76.8	84.5	92.3	100.2	108.3	116.5
14½	13.4	27.2	34.3	41.5	48.8	56.3	63.8	71.5	79.4	87.3	95.3	103.5	111.9	120.3
14¾	13.8	28.1	35.5	42.9	50.5	58.2	66.0	73.9	82.0	90.2	98.4	106.9	115.5	124.2
15	14.3	29.1	36.7	44.3	52.1	60.1	68.1	76.3	84.7	93.1	101.7	110.4	119.2	128.2
15¼	14.8	30.0	37.9	45.8	53.9	62.0	70.4	78.8	87.4	96.1	104.9	113.9	123.0	132.2
15½	15.3	31.0	39.1	47.3	55.6	64.0	72.6	81.3	90.1	99.1	108.2	117.4	126.8	136.3
15¾	15.7	32.0	40.3	48.7	57.3	66.0	74.9	83.8	92.9	102.2	111.5	121.0	130.7	140.4
16	16.2	33.0	41.6	50.2	59.1	68.1	77.2	86.4	95.8	105.3	114.9	124.7	134.6	144.7
16¼	16.8	34.0	42.9	51.8	60.9	70.2	79.5	89.0	98.7	108.5	118.4	128.4	138.6	149.0
16½	17.3	35.1	44.2	53.4	62.8	72.3	81.9	91.7	101.6	111.7	121.9	132.2	142.7	153.3
16¾	17.8	36.1	45.5	55.0	64.6	74.4	84.3	94.4	104.6	114.9	125.4	136.0	146.8	157.7
18¼	21.1	42.8	53.9	65.1	76.4	87.9	99.6	111.4	123.3	135.5	147.7	160.1	172.7	185.5
18½	21.7	43.9	55.3	66.8	78.5	90.3	102.2	114.3	126.6	139.0	151.6	164.3	177.2	190.3
20¼	26.0	52.5	66.1	79.8	93.6	107.7	121.9	136.2	150.8	165.5	180.3	195.4	210.6	226.0
20½	26.6	53.8	67.7	81.7	95.9	110.3	124.8	139.5	154.4	169.4	184.6	200.0	215.6	231.3
22¼	31.3	63.3	79.6	96.0	112.6	129.4	146.4	163.6	180.9	198.5	216.2	234.1	252.2	270.5
22½	32.0	64.7	81.3	98.1	115.1	132.3	149.6	167.2	184.9	202.8	220.9	239.2	257.6	276.3
24¼	37.1	75.0	94.3	113.7	133.3	153.2	173.2	193.4	213.8	234.5	255.3	276.3	297.5	319.0
24½	37.9	76.6	96.2	116.0	136.0	156.3	176.7	197.3	218.1	239.2	260.4	281.8	303.5	325.3
26¼	43.5	87.8	110.3	132.9	155.8	178.9	202.2	225.8	249.5	273.5	297.6	322.0	346.6	371.5
26½	44.3	89.4	112.3	135.4	158.7	182.3	206.0	230.0	254.1	278.5	303.1	328.0	353.0	378.3
28¼	50.3	101.5	127.5	153.7	180.0	206.7	233.5	260.6	287.9	315.5	343.2	371.2	399.5	428.0
28½	51.2	103.3	129.7	156.3	183.2	210.3	237.6	265.1	292.9	320.9	349.2	377.6	406.3	435.3

MOMENTS OF INERTIA OF TWO PLATES

Moments of Inertia of Two Plates
ONE INCH WIDE
About Axis X—X
Distances Measured from Inside to Inside



For Moments of Inertia, deducting for rivet holes, multiply tabular value by net width.

d Ins.	Thickness of Plates in Inches.													
	1/8	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
30¼	57.7	116.3	146.0	175.9	206.0	236.4	267.1	297.9	329.1	360 5	392.1	424.0	456.1	488.5
30½	58.6	118.2	148.4	178.7	209.4	240 3	271.4	302.8	334.4	366.3	398.4	430.8	463.4	496.3
32¼	65.5	132.0	165.7	199.6	233.8	268.2	302.8	337.8	373.0	408.5	444.2	480.2	516.4	553.0
32½	66.5	134.1	168.2	202.7	237.3	272.3	307.5	342.9	378.7	414.7	450.9	487.4	524.2	561.3
34¼	73.9	148.8	186.7	224.0	263.2	301.9	340.9	380.1	419.6	459.5	499.5	539.9	580.5	621.5
34½	74.9	150 9	189.4	228.1	267.0	306.3	345.8	385.6	425.7	466.0	506.7	547.6	588.8	630.3
36¼	82.7	166.5	208 9	251.5	294.5	337.7	381.2	425.0	469.1	513.5	558.1	603.1	648.3	694.0
36½	83.8	168.8	211.7	255.0	298.5	342.3	386.4	430.7	475.4	520.4	565.7	611.2	657.1	703.3
38¼	92.0	185.3	232.4	279.7	327.4	375.4	423.7	472.3	521.2	570.5	620.0	669.8	720.0	770.5
38½	93.2	187.7	235.4	283.4	331.7	380.3	429.2	478.4	527.9	577.8	627.9	678.4	729.2	780.3
40¼	101.9	205.0	257.1	309.5	362.2	415.2	468.5	522.2	576.1	630.5	685.1	740.1	795.3	851.0
40½	103.1	207.6	260.3	313.3	366.6	420.3	474.3	528.6	583.2	638.2	693.4	749.1	805.0	861.3
42¼	112.2	225.8	283.1	340.7	398.6	456.9	515.5	574.5	633.8	693.5	753.4	813.8	874.4	935.5
42½	113.6	228.4	286.4	344.7	403.3	462.3	521.6	581.2	641.2	701.5	762.2	823.2	884.6	946.3
44¼	123.1	247.5	310.3	373.4	436.9	500 7	564.8	629.4	694.2	759.5	825.0	891.0	957.3	1024.0
44½	124.6	250.3	313.8	377.6	441.7	506.3	571.1	636.4	702.0	767.9	834.2	900.9	967.9	1035.3
46¼	134.4	270.3	338.8	407.6	476.8	546.4	616.4	686.7	757.4	828.5	899.9	971.7	1043.9	1116.5
46½	135.9	273.2	342 4	412.0	481.9	552.3	623.0	694.0	765.5	837.3	909.5	982.0	1055.0	1128.3
48¼	146 3	294.0	368.5	443.4	518.6	594.2	670.2	746.5	823.3	900.5	978.0	1055.9	1134.3	1213.0
48½	147.8	297.1	372.3	447.9	523.9	600.3	677.0	754.2	831.7	909.7	988.0	1066.7	1145.8	1225.3
50¼	158.6	318.8	399.5	480.6	562.0	643.9	726.2	808.9	892.0	975.5	1059.4	1143.6	1228.4	1313.5
50½	160.2	321.9	403.4	485.3	567.6	650.3	733.4	816.8	900.7	985.0	1069.7	1154.8	1240.4	1326.3
52¼	171 5	344 5	431.7	519.3	607.3	695.7	784.5	873.7	963.4	1053.5	1144.0	1234.9	1326.2	1418.0
52½	173 1	347.8	435.8	524.2	613.0	702.3	791.9	882.0	972.5	1063.4	1154.7	1246.5	1338.7	1431.3
54¼	184.8	371.3	465.2	559.5	654.3	749.4	845.0	941.1	1037.5	1134.5	1231.8	1329.6	1427.8	1526.5
54½	186.5	374.7	469 4	564.6	660.2	756.3	852.7	949.7	1047.0	1144.8	1243.0	1341.7	1440.8	1540.3
56¼	198.6	399.0	499.9	601.2	703.0	805.2	907.8	1010.9	1114.5	1218.5	1322.9	1427.8	1533.2	1639.0
56½	200.4	402.6	504.3	606.5	709.2	812.3	915.8	1019.8	1124.3	1229.2	1334.5	1440.3	1546.6	1653.3
58½	214.8	431.4	540.5	649.9	759.9	870.3	981.1	1092.5	1204.3	1316.5	1429.3	1542.5	1656.1	1770.3
60½	229.7	461 3	577.8	694.8	812.3	930.3	1048.7	1167.6	1287.0	1406.9	1527.3	1648.1	1769.5	1891.3
62½	245.1	492.2	616.5	741.2	866.5	992.3	1118.5	1245.3	1372.5	1500.3	1628.5	1757.3	1886.5	2016.3
64½	261.0	524.1	656.4	789.1	922.4	1056.3	1190.6	1325.4	1460.8	1596.7	1733.0	1869.9	2007.4	2145.3
66½	277.4	556.9	697.5	838.6	980.1	1122.3	1264.9	1408.1	1551.8	1696.0	1840.8	1986.1	2131.9	2278.3
68½	294.3	590.8	739.9	889.5	1039.6	1190.3	1341.5	1493.2	1645.6	1798.4	1951.8	2105.7	2260 2	2415.3
70½	311.7	625 7	783.5	941.9	1100.8	1260 3	1420.3	1580 9	1742.1	1903.8	2066.1	2228 9	2392.3	2556.3
72½	329.6	661.6	828.4	995.8	1163.7	1332.3	1501.4	1671.1	1841.3	2012.2	2183.6	2355.5	2528.1	2701.3
74½	348.0	698 4	874.5	1051.2	1228.4	1406 3	1584.7	1763.7	1943 3	2123.5	2304.3	2485.7	2667.7	2850.3
76½	367.0	736.3	921.9	1108.1	1294.9	1482.3	1670 3	1858.9	2048.1	2237.9	2428.3	2619 4	2811 0	3003.3
78½	386.4	775.2	970.5	1166.5	1363.1	1560.3	1758.1	1956.5	2155.6	2355 3	2555.6	2756.5	2958.1	3160.3
80½	406.3	815.1	1020.4	1226.4	1433.0	1640.3	1848.2	2056.7	2265.9	2475.7	2686.1	2897.2	3108.9	3321.3
82½	426.7	855.9	1071.6	1287.8	1504.7	1722.3	1940.5	2159.3	2378.9	2599.0	2819.9	3041.3	3263 5	3486.3
84½	447.6	897.8	1123.9	1350.7	1578 1	1806.3	2035.0	2264.5	2494.6	2725 4	2956.9	3189.0	3421.8	3655 3
86½	469.0	940.7	1177.6	1415.1	1653 3	1892.3	2131.9	2372 1	2613.1	2854.8	3097.1	3340 1	3583.9	3828 3
88½	490 9	984.6	1232.5	1481.0	1730.3	1980.3	2230.9	2482 3	2734.4	2987.2	3240.6	3494.8	3749.7	4005 3
90½	513 3	1029.4	1288.6	1548.4	1809.0	2070.3	2332.3	2595.0	2858.4	3122.5	3387.4	3653 0	3919 3	4186.3
92½	536 2	1075.3	1346.0	1617.4	1889.4	2162.3	2435.8	2710.1	2985.2	3260.9	3537.4	3814.6	4092 6	4371.3
94½	559.6	1122.2	1404 6	1687.7	1971.6	2256.3	2541.6	2827 8	3114.7	3402.3	3690.7	3979.8	4269 7	4560 3
96½	583.5	1170.1	1464 5	1759.6	2055.6	2352.3	2649.7	2947.9	3246.9	3546 7	3847.2	4148 4	4450.5	4753 3
98½	607.9	1218.9	1525.6	1833.0	2141.3	2450.3	2760.0	3070.6	3381.9	3694 0	4006.9	4320.6	4635.0	4950.3
100½	632.8	1268.8	1588 0	1908.0	2228.7	2550.3	2872.6	3195.7	3519.7	3844.4	4169.9	4496.2	4823 4	5151 3
102½	658.2	1319.7	1651.6	1984 4	2317 9	2652.3	2987.4	3323.4	3660.2	3997.8	4336.2	4675.4	5015.4	5356 3
104½	684.1	1371.6	1716.5	2062.3	2408.8	2756.3	3104.5	3453.6	3803.5	4154 2	4505.7	4858.0	5211.3	5565.3
106½	710 5	1424 4	1782.7	2141.7	2501.5	2862.3	3223.8	3586.2	3949.5	4313 5	4678.5	5044.2	5410.8	5778.3
108½	737.5	1478.3	1850.0	2222.6	2596 0	2970.3	3345.4	3721.4	4098.2	4475.9	4854.5	5233.9	5614.1	5995 3
110½	764.9	1533.2	1918.7	2305.0	2692.0	3080 3	3469.2	3859.0	4249.7	4641.3	5033.7	5427.0	5821.2	6216.3
112½	792.8	1589 1	1988.6	2388 9	2790.1	3192.3	3595.3	3999.2	4404.0	4809.7	5216.2	5623.7	6032 0	6441.3
114½	821.2	1645.9	2059.7	2474.3	2889.8	3306.3	3723.6	4141.8	4561.0	4981.0	5402.0	5823 8	6246.6	6670.3
116½	850.1	1703.8	2132.1	2561.2	2991.3	3422.3	3854.2	4287.0	4720 8	5155.4	5591.0	6027.5	6464 9	6903 3
118½	879.5	1762 7	2205.7	2649 6	3094.5	3540.3	3987.0	4434.6	4883.3	5332.8	5783.3	6234 6	6687.0	7140.3
120½	909.4	1822.6	2280.6	2739.5	3199.4	3660.3	4122.1	4584.8	5048.5	5513 2	5978.[illegible]	6445 3	6912 8	7381.3

AREAS OF RECTANGULAR SECTIONS

SQUARE INCHES

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.016	.031	.047	.063	.078	.094	.109	.125	.141	.156	.172	.188	.203	.22	.23	.25
1/2	.031	.063	.094	.125	.156	.188	.219	.250	.281	.313	.344	.375	.406	.44	.47	.50
3/4	.047	.094	.141	.188	.234	.281	.328	.375	.422	.469	.516	.563	.609	.66	.70	.75
1	.063	.125	.188	.250	.313	.375	.438	.500	.563	.625	.688	.750	.813	.88	.94	1.00
1 1/4	.078	.156	.234	.313	.391	.469	.547	.625	.703	.781	.859	.938	1.016	1.09	1.17	1.25
1 1/2	.094	.188	.281	.375	.469	.563	.656	.750	.844	.938	1.031	1.125	1.219	1.31	1.41	1.50
1 3/4	.109	.219	.328	.438	.547	.656	.766	.875	.984	1.094	1.203	1.313	1.422	1.53	1.64	1.75
2	.125	.250	.375	.500	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625	1.75	1.88	2.00
2 1/4	.141	.281	.422	.563	.703	.844	.984	1.125	1.266	1.406	1.547	1.688	1.828	1.97	2.11	2.25
2 1/2	.156	.313	.469	.625	781	.938	1.094	1.250	1.406	1.563	1.719	1.875	2.031	2.19	2.34	2.50
2 3/4	.172	.344	.516	.688	.859	1.031	1.203	1.375	1.547	1.719	1.891	2.063	2.234	2.41	2.58	2.75
3	.188	.375	.563	.750	.938	1.125	1.313	1.500	1.688	1.875	2.063	2.250	2.438	2.63	2.81	3.00
3 1/4	.203	.406	.609	.813	1.016	1.219	1.422	1.625	1.828	2.031	2.234	2.438	2.641	2.84	3.05	3.25
3 1/2	.219	.438	.656	.875	1.094	1.313	1.531	1.750	1.969	2.188	2.406	2.625	2.844	3.06	3.28	3.50
3 3/4	.234	.469	.703	.938	1.172	1.406	1.641	1.875	2.109	2.344	2.578	2.813	3.047	3.28	3.52	3.75
4	.250	.500	.750	1.000	1.250	1.500	1.750	2.000	2.250	2.500	2.750	3.000	3.250	3.50	3.75	4.00
4 1/4	.266	.531	.797	1.063	1.328	1.594	1.859	2.125	2.391	2.656	2.922	3.188	3.453	3.72	3.98	4.25
4 1/2	.281	.563	.844	1.125	1.406	1.688	1.969	2.250	2.531	2.813	3.094	3.375	3.656	3.94	4.22	4.50
4 3/4	.297	.594	.891	1.188	1.484	1.781	2.078	2.375	2.672	2.969	3.266	3.563	3.859	4.16	4.45	4.75
5	.313	.625	.938	1.250	1.563	1.875	2.188	2.500	2.813	3.125	3.438	3.750	4.063	4.38	4.69	5.00
5 1/4	.328	.656	.984	1.313	1.641	1.969	2.297	2.625	2.953	3.281	3.609	3.938	4.266	4.59	4.92	5.25
5 1/2	.344	.688	1.031	1.375	1.719	2.063	2.406	2.750	3.094	3.438	3.781	4.125	4.469	4.81	5.16	5.50
5 3/4	.359	.719	1.078	1.438	1.797	2.156	2.516	2.875	3.234	3.594	3.953	4.313	4.672	5.03	5.39	5.75
6	.375	.750	1.125	1.500	1.875	2.250	2.625	3.000	3.375	3.750	4.125	4.500	4.875	5.25	5.63	6.00
6 1/4	.391	.781	1.172	1.563	1.953	2.344	2.734	3.125	3.516	3.906	4.297	4.688	5.078	5.47	5.86	6.25
6 1/2	.406	.813	1.219	1.625	2.031	2.438	2.844	3.250	3.656	4.063	4.469	4.875	5.281	5.69	6.09	6.50
6 3/4	.422	.844	1.266	1.688	2.109	2.531	2.953	3.375	3.797	4.219	4.641	5.063	5.484	5.91	6.33	6.75
7	.438	.875	1.313	1.750	2.188	2.625	3.063	3.500	3.938	4.375	4.813	5.250	5.688	6.13	6.56	7.00
7 1/4	.453	.906	1.359	1.813	2.266	2.719	3.172	3.625	4.078	4.531	4.984	5.438	5.891	6.34	6.80	7.25
7 1/2	.469	.938	1.406	1.875	2.344	2.813	3.281	3.750	4.219	4.688	5.156	5.625	6.094	6.56	7.03	7.50
7 3/4	.484	.969	1.453	1.938	2.422	2.906	3.391	3.875	4.359	4.844	5.328	5.813	6.297	6.78	7.27	7.75
8	.500	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500	5.000	5.500	6.000	6.500	7.00	7.50	8.00
8 1/4	.516	1.031	1.547	2.063	2.578	3.094	3.609	4.125	4.641	5.156	5.672	6.188	6.703	7.22	7.73	8.25
8 1/2	.531	1.063	1.594	2.125	2.656	3.188	3.719	4.250	4.781	5.313	5.844	6.375	6.906	7.44	7.97	8.50
8 3/4	.547	1.094	1.641	2.188	2.734	3.281	3.828	4.375	4.922	5.469	6.016	6.563	7.109	7.66	8.20	8.75
9	.563	1.125	1.688	2.250	2.813	3.375	3.938	4.500	5.063	5.625	6.188	6.750	7.313	7.88	8.44	9.00
9 1/4	.578	1.156	1.734	2.313	2.891	3.469	4.047	4.625	5.203	5.781	6.359	6.938	7.516	8.09	8.67	9.25
9 1/2	.594	1.188	1.781	2.375	2.969	3.563	4.156	4.750	5.344	5.938	6.531	7.125	7.719	8.31	8.91	9.50
9 3/4	.609	1.219	1.828	2.438	3.047	3.656	4.266	4.875	5.484	6.094	6.703	7.313	7.922	8.53	9.14	9.75
10	.625	1.250	1.875	2.500	3.125	3.750	4.375	5.000	5.625	6.250	6.875	7.500	8.125	8.75	9.38	10.00
10 1/4	.641	1.281	1.922	2.563	3.203	3.844	4.484	5.125	5.766	6.406	7.047	7.688	8.328	8.97	9.61	10.25
10 1/2	.656	1.313	1.969	2.625	3.281	3.938	4.594	5.250	5.906	6.563	7.219	7.875	8.531	9.19	9.84	10.50
10 3/4	.672	1.344	2.016	2.688	3.359	4 031	4.703	5.375	6.047	6.719	7.391	8.063	8.734	9.41	10.08	10.75
11	.688	1.375	2.063	2.750	3.438	4.125	4.813	5.500	6.188	6.875	7.563	8.250	8.938	9.63	10.31	11.00
11 1/4	.703	1.406	2.109	2.813	3.516	4.219	4.922	5.625	6.328	7.031	7.734	8.438	9.141	9.84	10.55	11.25
11 1/2	.719	1.438	2.156	2.875	3.594	4.313	5.031	5.750	6.469	7.188	7.906	8.625	9.344	10.06	10.78	11.50
11 3/4	.734	1.469	2.203	2.938	3.672	4.406	5.141	5.875	6.609	7.344	8.078	8.813	9.547	10.28	11.02	11.75
12	.750	1.500	2.250	3.000	3.750	4.500	5.250	6.000	6.750	7.500	8.250	9.000	9.750	10.50	11.25	12.00
12 1/2	.781	1.563	2.344	3.13	3.91	4.69	5.47	6.25	7.03	7.81	8.59	9.38	10.16	10.94	11.72	12.50
13	.813	1.625	2.438	3.25	4.06	4.88	5.69	6.50	7.31	8.13	8.94	9.75	10.56	11.38	12.19	13.00
13 1/2	.844	1.688	2.531	3.38	4.22	5.06	5.91	6.75	7.59	8.44	9.28	10.13	10.97	11.81	12.66	13.50
14	.875	1.750	2.625	3.50	4.38	5.25	6.13	7.00	7.88	8.75	9.63	10.50	11.38	12.25	13.13	14.00
14 1/2	.906	1.813	2.719	3.63	4.53	5.44	6.34	7.25	8.16	9.06	9.97	10.88	11.78	12.69	13.59	14.50
15	.938	1.875	2.813	3.75	4.69	5.63	6.56	7.50	8.44	9.38	10.31	11.25	12.19	13.13	14.06	15.00
15 1/2	.969	1.938	2.906	3.88	4.84	5.81	6.78	7.75	8.72	9.69	10.66	11.63	12.59	13.56	14.53	15.50
16	1.000	2.000	3.000	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00
16 1/2	1.031	2.063	3.094	4.13	5.16	6.19	7.22	8.25	9.28	10.31	11.34	12.38	13.41	14.44	15.47	16.50
17	1.063	2.125	3.188	4.25	5.31	6.38	7.44	8.50	9.56	10.63	11.69	12.75	13.81	14.88	15.94	17.00
17 1/2	1.094	2.188	3.281	4.38	5.47	6.56	7.66	8.75	9.84	10.94	12.03	13.13	14.22	15.31	16.41	17.50
18	1.125	2.250	3.375	4.50	5.63	6.75	7.88	9.00	10.13	11.25	12.38	13.50	14.63	15.75	16.88	18.00
18 1/2	1.156	2.313	3.469	4.63	5.78	6.94	8.09	9.25	10.41	11.56	12.72	13.88	15.03	16.19	17.34	18.50
19	1.188	2.375	3.563	4.75	5.94	7.13	8.31	9.50	10.69	11.88	13.06	14.25	15.44	16.63	17.81	19.00
19 1/2	1.219	2.438	3.656	4.88	6.09	7.31	8.53	9.75	10.97	12.19	13.41	14.63	15.84	17.06	18.28	19.50
20	1.250	2.500	3.750	5.00	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00	16.25	17.50	18.75	20.00
20 1/2	1.281	2.563	3.844	5.13	6.41	7.69	8.97	10.25	11.53	12.81	14.09	15.38	16.66	17.94	19.22	20.50
21	1.313	2.625	3.938	5.25	6.56	7.88	9.19	10.50	11.81	13.13	14.44	15.75	17.06	18.38	19.69	21.00
21 1/2	1.344	2.688	4.031	5.38	6.72	8.06	9.41	10.75	12.09	13.44	14.78	16.13	17.47	18.81	20.16	21.50
22	1.375	2.750	4 125	5.50	6.88	8.25	9.63	11.00	12.38	13.75	15.13	16.50	17.88	19.25	20.63	22.00

AREAS OF RECTANGULAR SECTIONS

SQUARE INCHES

Width, Inches	Thickness, Inches 1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
22½	1.406	2.813	4.219	5.63	7.03	8.44	9.84	11.25	12.66	14.06	15.47	16.88	18.28	19.69	21.09	22.50
23	1.438	2.875	4.313	5.75	7.19	8.63	10.06	11.50	12.94	14.38	15.81	17.25	18.69	20.13	21.56	23.00
23½	1.469	2.938	4.406	5.88	7.34	8.81	10.28	11.75	13.22	14.69	16.16	17.63	19.09	20.56	22.03	23.50
24	1.500	3.000	4.500	6.00	7.50	9.00	10.50	12.00	13.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00
25	1.563	3.125	4.688	6.25	7.81	9.38	10.94	12.50	14.06	15.63	17.19	18.75	20.31	21.88	23.44	25.00
26	1.625	3.250	4.875	6.50	8.13	9.75	11.38	13.00	14.63	16.25	17.88	19.50	21.13	22.75	24.38	26.00
27	1.688	3.375	5.063	6.75	8.44	10.13	11.81	13.50	15.19	16.88	18.56	20.25	21.94	23.63	25.31	27.00
28	1.750	3.500	5.250	7.00	8.75	10.50	12.25	14.00	15.75	17.50	19.25	21.00	22.75	24.50	26.25	28.00
29	1.813	3.625	5.438	7.25	9.06	10.88	12.69	14.50	16.31	18.13	19.94	21.75	23.56	25.38	27.19	29.00
30	1.875	3.750	5.625	7.50	9.38	11.25	13.13	15.00	16.88	18.75	20.63	22.50	24.38	26.25	28.13	30.00
31	1.938	3.875	5.813	7.75	9.69	11.63	13.56	15.50	17.44	19.38	21.31	23.25	25.19	27.13	29.06	31.00
32	2.000	4.000	6.000	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00
33	2.063	4.125	6.188	8.25	10.31	12.38	14.44	16.50	18.56	20.63	22.69	24.75	26.81	28.88	30.94	33.00
34	2.125	4.250	6.375	8.50	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00
35	2.188	4.375	6.563	8.75	10.94	13.13	15.31	17.50	19.69	21.88	24.06	26.25	28.44	30.63	32.81	35.00
36	2.250	4.500	6.750	9.00	11.25	13.50	15.75	18.00	20.25	22.50	24.75	27.00	29.25	31.50	33.75	36.00
37	2.313	4.625	6.938	9.25	11.56	13.88	16.19	18.50	20.81	23.13	25.44	27.75	30.06	32.38	34.69	37.00
38	2.375	4.750	7.125	9.50	11.88	14.25	16.63	19.00	21.38	23.75	26.13	28.50	30.88	33.25	35.63	38.00
39	2.438	4.875	7.313	9.75	12.19	14.63	17.06	19.50	21.94	24.38	26.81	29.25	31.69	34.13	36.56	39.00
40	2.500	5.000	7.500	10.00	12.50	15.00	17.50	20 00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00
41	2.563	5.125	7.688	10.25	12 81	15.38	17.94	20.50	23.06	25.63	28.19	30.75	33.31	35.88	38.44	41.00
42	2.625	5.250	7.875	10.50	13.13	15.75	18.38	21.00	23.63	26.25	28.88	31.50	34.13	36.75	39.38	42.00
43	2.688	5.375	8.063	10.75	13.44	16.13	18.81	21.50	24.19	26.88	29.56	32.25	34.94	37.63	40.31	43.00
44	2.750	5.500	8.250	11.00	13.75	16.50	19.25	22.00	24.75	27.50	30.25	33.00	35.75	38.50	41.25	44.00
45	2.813	5.625	8.438	11.25	14.06	16.88	19.69	22.50	25.31	28.13	30.94	33.75	36.56	39.38	42.19	45.00
46	2.875	5.750	8.625	11.50	14.38	17.25	20.13	23.00	25.88	28.75	31.63	34.50	37.38	40.25	43.13	46.00
47	2.938	5 875	8.813	11.75	14 69	17.63	20.56	23.50	26.44	29.38	32.31	35.25	38.19	41.13	44.06	47.00
48	3.000	6.000	9.000	12.00	15.00	18.00	21 00	24.00	27.00	30.00	33.00	36.00	39.00	42.00	45.00	48.00
49	3.06	6.13	9.19	12.25	15.31	18.38	21.44	24.50	27.56	30.63	33.69	36.75	39.81	42.88	45.94	49.00
50	3.13	6.25	9.38	12.50	15.63	18.75	21.88	25.00	28.13	31.25	34.38	37.50	40.63	43 75	46.88	50.00
51	3.19	6.38	9.56	12.75	15.94	19.13	22.31	25.50	28.69	31.88	35.06	38.25	41.44	44.63	47.81	51.00
52	3.25	6.50	9.75	13.00	16.25	19.50	22.75	26.00	29.25	32.50	35.75	39.00	42.25	45.50	48.75	52.00
53	3.31	6.63	9.94	13.25	16.56	19.88	23.19	26.50	29.81	33.13	36.44	39.75	43.06	46.38	49.69	53.00
54	3.38	6.75	10.13	13.50	16.88	20.25	23.63	27.00	30.38	33.75	37.13	40.50	43.88	47.25	50.63	54.00
55	3.44	6.88	10.31	13.75	17.19	20.63	24.06	27.50	30.94	34.38	37.81	41.25	44.69	48.13	51.56	55.00
56	3.50	7.00	10.50	14.00	17.50	21.00	24.50	28.00	31.50	35.00	38.50	42.00	45.50	49.00	52.50	56.00
57	3.56	7.13	10.69	14.25	17.81	21.38	24.94	28.50	32.06	35.63	39.19	42.75	46.31	49.88	53.44	57.00
58	3.63	7.25	10.88	14.50	18.13	21.75	25.38	29.00	32.63	36.25	39.88	43.50	47.13	50.75	54 38	58.00
59	3.69	7.38	11.06	14.75	18.44	22.13	25.81	29.50	33.19	36.88	40.56	44.25	47.94	51.63	55.31	59.00
60	3.75	7.50	11.25	15.00	18.75	22.50	26.25	30.00	33.75	37.50	41.25	45.00	48.75	52.50	56.25	60.00
61	3.81	7.63	11.44	15.25	19.06	22.88	26.69	30.50	34.31	38.13	41.94	45.75	49.56	53.38	57.19	61.00
62	3.88	7.75	11.63	15.50	19.38	23.25	27.13	31.00	34.88	38.75	42.63	46.50	50.38	54.25	58.13	62.00
63	3.94	7.88	11.81	15.75	19.69	23.63	27.56	31.50	35.44	39.38	43.31	47.25	51.19	55.13	59.06	63.00
64	4.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00	36.00	40.00	44.00	48.00	52.00	56.00	60.00	64.00
65	4.06	8.13	12.19	16.25	20.31	24.38	28.44	32.50	36.56	40.63	44.69	48.75	52.81	56.88	60.94	65.00
66	4.13	8.25	12.38	16.50	20.63	24.75	28.88	33.00	37.13	41.25	45.38	49.50	53.63	57.75	61.88	66.00
67	4.19	8.38	12.56	16.75	20.94	25.13	29.31	33.50	37.69	41.88	46.06	50.25	54.44	58.63	62.81	67.00
68	4.25	8.50	12 75	17.00	21.25	25.50	29.75	34.00	38.25	42.50	46.75	51.00	55.25	59.50	63.75	68.00
69	4.31	8.63	12.94	17.25	21.56	25.88	30.19	34.50	38.81	43.13	47.44	51.75	56.06	60.38	64.69	69.00
70	4.38	8.75	13.13	17.50	21.88	26.25	30.63	35.00	39.38	43.75	48.13	52.50	56.88	61.25	65.63	70.00
71	4.44	8.88	13.31	17.75	22.19	26.63	31.06	35.50	39.94	44.38	48.81	53.25	57.69	62.13	66.56	71.00
72	4.50	9.00	13.50	18.00	22.50	27.00	31.50	36.00	40.50	45.00	49.50	54.00	58.50	63.00	67.50	72.00
73	4.56	9.13	13.69	18.25	22.81	27.38	31.94	36.50	41.06	45.63	50.19	54.75	59.31	63.88	68.44	73.00
74	4.63	9.25	13.88	18.50	23.13	27.75	32.38	37.00	41.63	46.25	50.88	55.50	60.13	64.75	69.38	74.00
75	4.69	9.38	14.06	18.75	23.44	28.13	32.81	37.50	42.19	46.88	51.56	56.25	60.94	65.63	70.31	75.00
76	4.75	9.50	14.25	19.00	23.75	28.50	33.25	38.00	42.75	47.50	52.25	57.00	61.75	66.50	71.25	76.00
78	4.88	9.75	14.63	19.50	24.38	29.25	34.13	39.00	43.88	48.75	53.63	58.50	63.38	68.25	73.13	78.00
80	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00
82	5.13	10.25	15.38	20.50	25.63	30.75	35.88	41.00	46.13	51.25	56.38	61.50	66.63	71.75	76.88	82.00
84	5.25	10.50	15.75	21.00	26.25	31.50	36.75	42.00	47.25	52.50	57.75	63.00	68.25	73.50	78.75	84.00
86	5.38	10.75	16.13	21 50	26.88	32.25	37.63	43.00	48.38	53.75	59.13	64.50	69.88	75.25	80.63	86.00
88	5.50	11.00	16.50	22.00	27.50	33.00	38.50	44.00	49.50	55.00	60.50	66.00	71.50	77.00	82.50	88.00
90	5.63	11.25	16.88	22.50	28.13	33.75	39.38	45.00	50.63	56.25	61.88	67.50	73.13	78.75	84.38	90.00
92	5.75	11.50	17.25	23.00	28.75	34.50	40.25	46.00	51.75	57.50	63.25	69.00	74.75	80.50	86.25	92.00
94	5.88	11.75	17.63	23.50	29.38	35.25	41.13	47.00	52.88	58.75	64.63	70.50	76.38	82.25	88.13	94.00
96	6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00	60.00	66.00	72.00	78 00	84.00	90.00	96.00
98	6 13	12.25	18.38	24.50	30.63	36.75	42.88	49.00	55.13	61.25	67.38	73.50	79 63	85.75	91.88	98.00
100	6.25	12.50	18.75	25.00	31.25	37.50	43.75	50.00	56.25	62.50	68.75	75.00	81.25	87.50	93.75	100.0

WEIGHTS OF FLAT ROLLED STEEL

POUNDS PER LINEAR FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.053	.106	.159	.213	.27	.32	.37	.43	.48	.53	.58	.64	69	.74	.80	.85
1/2	.106	.213	.319	.425	.53	.64	.74	.85	.96	1.06	1.17	1.28	1.38	1.49	1.59	1.70
3/4	.159	.319	.478	.638	.80	.96	1.12	1.28	1.43	1.59	1.75	1.91	2.07	2.23	2.39	2.55
1	.213	.425	.638	.850	1.06	1.28	1.49	1.70	1.91	2.13	2.34	2.55	2.76	2.98	3.19	3.40
1 1/4	.266	.531	.797	1.063	1.33	1.59	1.86	2.13	2.39	2.66	2.92	3.19	3.45	3.72	3.98	4.25
1 1/2	.319	.638	.956	1.275	1.59	1.91	2.23	2.55	2.87	3.19	3.51	3.83	4.14	4.46	4.78	5.10
1 3/4	.372	.744	1.116	1.488	1.86	2.23	2.60	2.98	3.35	3.72	4.09	4.46	4.83	5.21	5.58	5.95
2	.425	.850	1.275	1.700	2.13	2.55	2.98	3.40	3.83	4.25	4.68	5.10	5.53	5.95	6.38	6.80
2 1/4	.478	.956	1.434	1.913	2.39	2.87	3.35	3.83	4.30	4.78	5.26	5.74	6.22	6.69	7.17	7.65
2 1/2	.531	1.063	1.594	2.125	2.66	3.19	3.72	4.25	4.78	5.31	5.84	6.38	6.91	7.44	7.97	8.50
2 3/4	.584	1.169	1.753	2.338	2.92	3.51	4.09	4.68	5.26	5.84	6.43	7.01	7.60	8.18	8.77	9.35
3	.638	1.275	1.913	2.550	3.19	3.83	4.46	5.10	5.74	6.38	7.01	7.65	8.29	8.93	9.56	10.20
3 1/4	.691	1.381	2.072	2.763	3.45	4.14	4.83	5.53	6.22	6.91	7.60	8.29	8.98	9.67	10.36	11.05
3 1/2	.744	1.488	2.231	2.975	3.72	4.46	5.21	5.95	6.69	7.44	8.18	8.93	9.67	10.41	11.16	11.90
3 3/4	.797	1.594	2.391	3.188	3.98	4.78	5.58	6.38	7.17	7.97	8.77	9.56	10.36	11.16	11.95	12.75
4	.850	1.700	2.550	3.400	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60
4 1/4	.903	1.806	2.709	3.613	4.52	5.42	6.32	7.23	8.13	9.03	9.93	10.84	11.74	12.64	13.55	14.45
4 1/2	.956	1.913	2.869	3.825	4.78	5.74	6.69	7.65	8.61	9.56	10.52	11.48	12.43	13.39	14.34	15.30
4 3/4	1.009	2.019	3.028	4.038	5.05	6.06	7.07	8.08	9.08	10.09	11.10	12.11	13.12	14.13	15.14	16.15
5	1.063	2.125	3.188	4.250	5.31	6.38	7.44	8.50	9.56	10.63	11.69	12.75	13.81	14.88	15.94	17.00
5 1/4	1.116	2.231	3.347	4.463	5.58	6.69	7.81	8.93	10.04	11 16	12.27	13.39	14.50	15.62	16.73	17.85
5 1/2	1.169	2.338	3.506	4.675	5.84	7.01	8.18	9.35	10.52	11 69	12.86	14.03	15.19	16.36	17.53	18.70
5 3/4	1.222	2.444	3.666	4.888	6.11	7.33	8.55	9.78	11.00	12.22	13.44	14.66	15.88	17.11	18.33	19.55
6	1.275	2.550	3.825	5.100	6.38	7.65	8.93	10.20	11.48	12.75	14.03	15.30	16.58	17.85	19.13	20.40
6 1/4	1.328	2.656	3.984	5.313	6.64	7.97	9.30	10.63	11.95	13.28	14 61	15.94	17.27	18.59	19.92	21.25
6 1/2	1.381	2.763	4.144	5.525	6.91	8.29	9.67	11.05	12.43	13.81	15.19	16.58	17.96	19.34	20.72	22.10
6 3/4	1.434	2.869	4.303	5.738	7.17	8.61	10.04	11 48	12.91	14.34	15.78	17.21	18.65	20.08	21.52	22.95
7	1.488	2.975	4.463	5.950	7.44	8.93	10.41	11.90	13.39	14.88	16.36	17.85	19.34	20.83	22.31	23.80
7 1/4	1.541	3.081	4.622	6.163	7.70	9.24	10.78	12.33	13.87	15.41	16.95	18.49	20.03	21.57	23.11	24.65
7 1/2	1.594	3.188	4.781	6.375	7.97	9.56	11.16	12.75	14.34	15.94	17.53	19.13	20.72	22.31	23.91	25.50
7 3/4	1.647	3.294	4.941	6.588	8.23	9.88	11.53	13.18	14.82	16.47	18.12	19.76	21.41	23.06	24.70	26.35
8	1.700	3.400	5.100	6.800	8.50	10.20	11.90	13.60	15.30	17.00	18.70	20.40	22.10	23.80	25.50	27.20
8 1/4	1.753	3.506	5.259	7.013	8.77	10.52	12.27	14.03	15.78	17.53	19.28	21.04	22.79	24.54	26.30	28.05
8 1/2	1.806	3.613	5.419	7.225	9.03	10.84	12.64	14.45	16.26	18.06	19.87	21.68	23.48	25.29	27.09	28.90
8 3/4	1.859	3.719	5.578	7.438	9.30	11.16	13.02	14.88	16.73	18.59	20.45	22.31	24.17	26.03	27.89	29.75
9	1.913	3.825	5.738	7.650	9.56	11.48	13.39	15.30	17.21	19.13	21.04	22.95	24.86	26.78	28.69	30.60
9 1/4	1.966	3.931	5.897	7.863	9.83	11.79	13.76	15.73	17.69	19.66	21.62	23.59	25.55	27.52	29.48	31.45
9 1/2	2.019	4.038	6.056	8.075	10.09	12.11	14.13	16.15	18.17	20.19	22.21	24.23	26.24	28.26	30.28	32.30
9 3/4	2.072	4.144	6.216	8.288	10.36	12.43	14.50	16.58	18.65	20.72	22.79	24.86	26.93	29.01	31.08	33.15
10	2.125	4.250	6.375	8.500	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50	27.63	29.75	31.88	34.00
10 1/4	2.178	4.356	6.534	8.713	10.89	13.07	15.25	17.43	19.60	21.78	23.96	26.14	28.32	30.49	32.67	34.85
10 1/2	2.231	4.463	6.694	8.925	11.16	13.39	15.62	17.85	20.08	22.31	24.54	26.78	29.01	31.24	33.47	35.70
10 3/4	2.284	4.569	6.853	9.138	11.42	13.71	15.99	18.28	20.56	22.84	25.13	27 41	29.70	31.98	34.27	36.55
11	2.338	4.675	7.013	9.350	11.69	14.03	16.36	18.70	21 04	23.38	25.71	28.05	30.39	32.73	35.06	37.40
11 1/4	2 391	4.781	7.172	9.563	11.95	14.34	16.73	19.13	21.52	23.91	26.30	28.69	31.08	33.47	35.86	38.25
11 1/2	2.444	4.888	7.331	9.775	12.22	14.66	17.11	19 55	21.99	24.44	26.88	29.33	31.77	34.21	36.66	39.10
11 3/4	2.497	4.994	7.491	9.988	12.48	14.98	17.48	19.98	22.47	24.97	27.47	29.96	32.46	34.96	37.45	39.95
12	2.550	5.100	7.650	10.20	12.75	15.30	17.85	20.40	22.95	25.50	28.05	30.60	33.15	35.70	38.25	40.80
12 1/2	2.66	5.31	7.97	10 63	13.28	15.94	18.59	21.25	23.91	26.56	29.2	31.9	34.5	37.2	39.8	42.5
13	2.76	5.53	8.29	11.05	13.81	16.58	19.34	22.10	24.86	27.63	30.4	33.2	35.9	38.7	41.4	44.2
13 1/2	2.87	5 74	8.61	11.48	14.34	17.21	20.08	22.95	25.82	28.69	31.6	34.4	37.3	40.2	43 0	45.9
14	2 98	5.95	8.93	11 90	14.88	17.85	20.83	23.80	26.78	29.75	32.7	35.7	38.7	41.7	44.6	47.6
14 1/2	3.08	6.16	9.24	12.33	15.41	18.49	21.57	24.65	27.73	30.81	33.9	37.0	40.1	43 1	46 2	49.3
15	3.19	6.38	9.56	12.75	15.94	19.13	22.31	25.50	28.69	31.88	35.1	38.3	41.4	44.6	47 8	51.0
15 1/2	3.29	6.59	9.88	13.18	16.47	19.76	23.06	26.35	29.64	32.94	36.2	39.5	42.8	46 1	49.4	52.7
16	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20	30.60	34.00	37.4	40.8	44.2	47 6	51.0	54.4
16 1/2	3.51	7.01	10 52	14 03	17.53	21.04	24.54	28.05	31.56	35.06	38.6	42.1	45.6	49 1	52.6	56.1
17	3.61	7.23	10.84	14.45	18.06	21.68	25.29	28.90	32.51	36.13	39.7	43.4	47 0	50.6	54.2	57.8
17 1/2	3.72	7.44	11.16	14.88	18.59	22.31	26.03	29.75	33.47	37.19	40.9	44 6	48.3	52 1	55.8	59.5
18	3.83	7.65	11.48	15.30	19.13	22.95	26.78	30.60	34.43	38.25	42.1	45.9	49.7	53.6	57 4	61.2
18 1/2	3.93	7.86	11.79	15.73	19.66	23.59	27.52	31.45	35.38	39.31	43.2	47.2	51.1	55.0	59 0	62.9
19	4.04	8.08	12.11	16.15	20.19	24.23	28.26	32.30	36.34	40.38	44.4	48.5	52.5	56.5	60.6	64 6
19 1/2	4.14	8.29	12.43	16.58	20.72	24.86	29.01	33.15	37.29	41.44	45.6	49.7	53.9	58.0	62.2	66.3
20	4 25	8.50	12.75	17.00	21.25	25.50	29.75	34.00	38.25	42.50	46.8	51.0	55.3	59.5	63.8	68.0
20 1/2	4.36	8.71	13.07	17.43	21.78	26.14	30.49	34.85	39.21	43.56	47 9	52.3	56.6	61.0	65.3	69.7
21	4.46	8.93	13.39	17.85	22.31	26.78	31.24	35.70	40.16	44.63	49.1	53.6	58.0	62.5	66.9	71.4
21 1/2	4.57	9.14	13.71	18.28	22 84	27.41	31.98	36.55	41.12	45.69	50.3	54.8	59.4	64.0	68.5	73.1
22	4.68	9.35	14.03	18.70	23.38	28.05	32.73	37.40	42.08	46.75	51.4	56.1	60.8	65.5	70.1	74.8

WEIGHTS OF FLAT ROLLED STEEL

POUNDS PER LINEAR FOOT

Width, Inches	Thickness, Inches															
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
22½	4.78	9.56	14.34	19.13	23.91	28.69	33.47	38.25	43.03	47.81	52.6	57.4	62.2	66.9	71.7	76.5
23	4.89	9.78	14.66	19.55	24.44	29.33	34.21	39.10	43.99	48.88	53.8	58.7	63.5	68.4	73.3	78.2
23½	4.99	9.99	14.98	19.98	24.97	29.96	34.96	39.95	44.94	49.94	54.9	59.9	64.9	69.9	74.9	79.9
24	5.10	10.20	15.30	20.40	25.50	30.60	35.70	40.80	45.90	51.00	56.1	61.2	66.3	71.4	76.5	81.6
25	5.31	10.63	15.94	21.25	26.56	31.88	37.19	42.50	47.81	53.13	58.4	63.8	69.1	74.4	79.7	85.0
26	5.53	11.05	16.58	22.10	27.63	33.15	38.68	44.20	49.73	55.25	60.8	66.3	71.8	77.4	82.9	88.4
27	5.74	11.48	17.21	22.95	28.69	34.43	40.16	45.90	51 64	57.38	63.1	68.9	74.6	80.3	86.1	91.8
28	5.95	11.90	17.85	23.80	29.75	35.70	41.65	47.60	53.55	59.50	65.5	71.4	77.4	83.3	89.3	95.2
29	6.16	12.33	18.49	24.65	30.81	36.98	43.14	49.30	55.46	61.63	67.8	74.0	80.1	86.3	92.4	98.6
30	6.38	12.75	19.13	25.50	31.88	38.25	44.63	51.00	57.38	63.75	70.1	76.5	82.9	89.3	95.6	102.0
31	6.59	13.18	19.76	26.35	32.94	39.53	46.11	52.70	59.29	65.88	72.5	79.1	85.6	92.2	98.8	105.4
32	6.80	13.60	20.40	27.20	34.00	40.80	47.60	54.40	61.20	68.00	74.8	81.6	88.4	95.2	102.0	108.8
33	7.01	14.03	21.04	28.05	35.06	42.08	49.09	56.10	63.11	70.13	77.1	84.2	91.2	98.2	105.2	112.2
34	7.23	14.45	21.68	28.90	36.13	43.35	50.58	57.80	65.03	72.25	79.5	86.7	93.9	101.2	108.4	115.6
35	7.44	14.88	22.31	29.75	37.19	44.63	52.06	59.50	66.94	74.38	81.8	89.3	96.7	104.1	111.6	119.0
36	7.65	15.30	22.95	30.60	38.25	45.90	53.55	61.20	68.85	76.50	84.2	91.8	99.5	107.1	114.8	122.4
37	7.86	15.73	23.59	31.45	39.31	47.18	55.04	62.90	70.76	78.63	86.5	94.4	102.2	110.1	117.9	125.8
38	8.08	16.15	24.23	32.30	40.38	48.45	56.53	64.60	72.68	80.75	88.8	96.9	105.0	113.1	121.1	129.2
39	8.29	16.58	24.86	33.15	41.44	49.73	58.01	66.30	74.59	82.88	91.2	99.5	107.7	116.0	124.3	132.6
40	8.50	17.00	25.50	34.00	42.50	51.00	59.50	68.00	76.50	85.00	93.5	102.0	110.5	119.0	127.5	136.0
41	8.71	17.43	26.14	34.85	43.56	52.28	60.99	69.70	78.41	87.13	95.8	104.6	113.3	122.0	130.7	139.4
42	8.93	17.85	26.78	35.70	44.63	53.55	62.48	71.40	80.33	89.25	98.2	107.1	116.0	125.0	133.9	142.8
43	9.14	18.28	27.41	36.55	45.69	54.83	63.96	73.10	82.24	91.38	100.5	109.7	118.8	127.9	137.1	146.2
44	9.35	18.70	28.05	37.40	46.75	56.10	65.45	74.80	84.15	93.50	102.9	112.2	121.6	130.9	140.3	149.6
45	9.56	19.13	28.69	38.25	47.81	57.38	66.94	76.50	86.06	95.63	105.2	114.8	124.3	133.9	143.4	153.0
46	9.78	19.55	29.33	39.10	48.88	58.65	68.43	78.20	87.98	97.75	107.5	117.3	127.1	136.9	146.6	156.4
47	9.99	19.98	29.96	39.95	49.94	59.93	69.91	79.90	89.89	99.88	109.9	119.9	129.8	139.8	149.8	159.8
48	10.20	20.40	30.60	40.80	51.00	61.20	71.40	81.60	91.80	102.0	112.2	122.4	132.6	142.8	153.0	163.2
49	10.4	20.8	31.2	41.7	52.1	62.5	72.9	83.3	93.7	104.1	114.5	125.0	135.4	145.8	156.2	166.6
50	10.6	21.3	31.9	42.5	53.1	63.8	74.4	85.0	95.6	106.3	116.9	127.5	138.1	148.8	159.4	170.0
51	10.8	21.7	32.5	43.4	54.2	65.0	75.9	86.7	97.5	108.4	119.2	130.1	140.9	151.7	162.6	173.4
52	11.1	22.1	33.2	44.2	55.3	66.3	77.4	88.4	99.5	110.5	121.6	132.6	143.7	154.7	165.8	176.8
53	11.3	22.5	33.8	45.1	56.3	67.6	78.8	90.1	101.4	112.6	123.9	135.2	146.4	157.7	168.9	180.2
54	11.5	23.0	34.4	45.9	57.4	68.9	80.3	91.8	103.3	114.8	126.2	137.7	149.2	160.7	172.1	183.6
55	11.7	23.4	35.1	46.8	58.4	70.1	81.8	93.5	105.2	116.9	128.6	140.3	151.9	163.6	175.3	187.0
56	11.9	23.8	35.7	47.6	59.5	71.4	83.3	95.2	107.1	119.0	130.9	142.8	154.7	166.6	178.5	190.4
57	12.1	24.2	36.3	48.5	60.6	72.7	84.8	96.9	109.0	121.1	133.2	145.4	157.5	169.6	181.7	193.8
58	12.3	24.7	37.0	49.3	61.6	74.0	86.3	98.6	110.9	123.3	135.6	147.9	160.2	172.6	184.9	197.2
59	12.5	25.1	37.6	50.2	62.7	75.2	87.8	100.3	112.8	125.4	137.9	150.5	163.0	175.5	188.1	200.6
60	12.8	25.5	38.3	51.0	63.8	76.5	89.3	102.0	114.8	127.5	140.3	153.0	165.8	178.5	191.3	204.0
61	13.0	25.9	38.9	51.9	64.8	77.8	90.7	103.7	116.7	129.6	142.6	155.6	168.5	181.5	194.4	207.4
62	13.2	26.4	39.5	52.7	65.9	79.1	92.2	105.4	118.6	131.8	144.9	158.1	171.3	184.5	197.6	210.8
63	13.4	26.8	40.2	53.6	66.9	80.3	93.7	107.1	120.5	133.9	147.3	160.7	174.0	187.4	200.8	214.2
64	13.6	27.2	40.8	54.4	68.0	81.6	95.2	108.8	122.4	136.0	149.6	163.2	176.8	190.4	204.0	217.6
65	13.8	27.6	41.4	55.3	69.1	82.9	96.7	110.5	124.3	138.1	151.9	165.8	179.6	193.4	207.2	221.0
66	14.0	28.1	42.1	56.1	70.1	84.2	98.2	112.2	126.2	140.3	154.3	168.3	182.3	196.4	210.4	224.4
67	14.2	28.5	42.7	57.0	71.2	85.4	99.7	113.9	128.1	142.4	156.6	170.9	185.1	199.3	213.6	227.8
68	14.5	28.9	43.4	57.8	72.3	86.7	101.2	115.6	130.1	144.5	159.0	173.4	187.9	202.3	216.8	231.2
69	14.7	29.3	44.0	58.7	73.3	88.0	102.6	117.3	132.0	146.6	161.3	176.0	190.6	205.3	219.9	234.6
70	14.9	29.8	44.6	59.5	74.4	89.3	104.1	119.0	133.9	148.8	163.6	178.5	193.4	208.3	223.1	238.0
71	15.1	30.2	45.3	60.4	75.4	90.5	105.6	120.7	135.8	150.9	166.0	181.1	196.1	211.2	226.3	241.4
72	15.3	30.6	45.9	61.2	76.5	91.8	107.1	122.4	137.7	153.0	168.3	183.6	198.9	214.2	229.5	244.8
73	15.5	31.0	46.5	62.1	77.6	93.1	108.6	124.1	139.6	155.1	170.6	186.2	201.7	217.2	232.7	248.2
74	15.7	31.5	47.2	62.9	78.6	94.4	110.1	125.8	141.5	157.3	173.0	188.7	204.4	220.2	235.9	251.6
75	15.9	31.9	47.8	63.8	79.7	95.6	111.6	127.5	143.4	159.4	175.3	191.3	207.2	223.1	239.1	255.0
76	16.2	32.3	48.5	64.6	80.8	96.9	113.1	129.2	145.4	161.5	177.7	193.8	210.0	226.1	242.3	258.4
78	16.6	33.2	49.7	66.3	82.9	99.5	116.0	132.6	149.2	165.8	182.3	198.9	215.5	232.1	248.6	265.2
80	17.0	34.0	51.0	68.0	85.0	102.0	119.0	136.0	153.0	170.0	187.0	204.0	221.0	238.0	255.0	272.0
82	17.4	34.9	52.3	69.7	87.1	104.6	122.0	139.4	156.8	174.3	191.7	209.1	226.5	244.0	261.4	278.8
84	17.9	35.7	53.6	71.4	89.3	107.1	125.0	142.8	160.7	178.5	196.4	214.2	232.1	249.9	267.8	285.6
86	18.3	36.6	54.8	73.1	91.4	109.7	127.9	146.2	164.5	182.8	201.0	219.3	237.6	255.9	274.1	292.4
88	18.7	37.4	56.1	74.8	93.5	112.2	130.9	149.6	168.3	187.0	205.7	224.4	243.1	261.8	280.5	299.2
90	19.1	38.3	57.4	76.5	95.6	114.8	133.9	153.0	172.1	191.3	210.4	229.5	248.6	267.8	286.9	306.0
92	19.6	39.1	58.7	78.2	97.8	117.3	136.9	156.4	176.0	195.5	215.1	234.6	254.2	273.7	293.3	312.8
94	20.0	40.0	59.9	79.9	99.9	119.9	139.8	159.8	179.8	199.8	219.7	239.7	259.7	279.7	299.6	319.6
96	20.4	40.8	61.2	81.6	102.0	122.4	142.8	163.2	183.6	204.0	224.4	244.8	265.2	285.6	306.0	326.4
98	20.8	41.7	62.5	83.3	104.1	125.0	145.8	166.6	187.4	208.3	229.1	249.9	270.7	291.6	312.4	333.2
100	21.3	42.5	63.8	85.0	106.3	127.5	148.8	170.0	191.3	212.5	233.8	255.0	276.3	297.5	318.8	340.0

WIRE AND SHEET METAL GAUGES

IN DECIMALS OF AN INCH

Number of Gauge	Birmingham or Stubs Iron Wire Gauge (B. W. G.)	American or Brown & Sharpe Wire Gauge.	United States Standard Gauge for Sheet and Plate Iron and Steel.	American Steel & Wire Co. formerly Washburn & Moen John A. Roebling's Sons Co.	Trenton Iron Co. Wire Gauge.	British Imperial or English Legal Standard Wire Gauge.	New Birmingham Standard Sheet and Hoop Gauge (B. G.)
0000000	....	....	.5	......	.....	.500	.6666
000000	....	....	.46875	.4600	.....	.464	.625
00000	....	....	.4375	.4300	.450	.432	.5883
0000	.454	.460000	.40625	.3938	.400	.400	.5416
000	.425	.409642	.375	.3625	.360	.372	.500
00	.380	.364796	.34375	.3310	.330	.348	.4452
0	.340	.324861	.3125	.3065	.305	.324	.3964
1	.300	.289297	.28125	.2830	.285	.300	.3532
2	.284	.257627	.265625	.2625	.265	.276	.3147
3	.259	.229423	.25	.2437	.245	.252	.2804
4	.238	.204307	.234375	.2253	.225	.232	.250
5	.220	.181940	.21875	.2070	.205	.212	.2225
6	.203	.162023	.203125	.1920	.190	.192	.1981
7	.180	.144285	.1875	.1770	.175	.176	.1764
8	.165	.128490	.171875	.1620	.160	.160	.1570
9	.148	.114423	.15625	.1483	.145	.144	.1398
10	.134	.101897	.140625	.1350	.130	.128	.1250
11	.120	.090742	.125	.1205	.1175	.116	.1113
12	.109	.080808	.109375	.1055	.105	.104	.0991
13	.095	.071962	.09375	.0915	.0925	.092	.0882
14	.083	.064084	.078125	.0800	.0806	.080	.0785
15	.072	.057068	.0703125	.0720	.070	.072	.0699
16	.065	.050821	.0625	.0625	.061	.064	.0625
17	.058	.045257	.05625	.0540	.0525	.056	.0556
18	.049	.040303	.05	.0475	.045	.048	.0495
19	.042	.035890	.04375	.0410	.040	.040	.0440
20	.035	.031961	.0375	.0348	.035	.036	.0392
21	.032	.028462	.034375	.03175	.031	.032	.0349
22	.028	.025346	.03125	.0286	.028	.028	.03125
23	.025	.022572	.028125	.0258	.025	.024	.02782
24	.022	.020101	.025	.0230	.0225	.022	.02476
25	.020	.017900	.021875	.0204	.020	.020	.02204
26	.018	.015941	.01875	.0181	.018	.018	.01961
27	.016	.014195	.0171875	.0173	.017	.0164	.01745
28	.014	.012641	.015625	.0162	.016	.0148	.015625
29	.013	.011257	.0140625	.0150	.015	.0136	.0139
30	.012	.010025	.0125	.0140	.014	.0124	.0123
31	.010	.008928	.0109375	.0132	.013	.0116	.0110
32	.009	.007950	.01015625	.0128	.012	.0108	.0098
33	.008	.007080	.009375	.0118	.011	.0100	.0087
34	.007	.006305	.00859375	.0104	.010	.0092	.0077
35	.005	.005615	.0078125	.0095	.0095	.0084	.0069
36	.004	.005000	.00703125	.0090	.009	.0076	.0061
37	....	.004453	.006640625	.0085	.0085	.0068	.0054
38	....	.003965	.00625	.0080	.008	.0060	.0048
39	....	.003531	....	.0075	.0075	.0052	.0043
40	....	.003144	....	.0070	.007	.0048	.00386

SQUARE AND ROUND BARS

WEIGHTS, AREAS AND CIRCUMFERENCE

1/16 TO 15/16

Thickness or Diameter in Inches	Weight in Pounds				Area in Sq. Inches		Circumference
	Square		Round		Square	Round	
	One Inch Long	One Foot Long	One Inch Long	One Foot Long			
1/16	.001	.013	.001	.010	.0039	.0031	.1964
5/64	.002	.021	.001	.016	.0061	.0048	.2454
3/32	.002	.030	.002	.023	.0088	.0069	.2945
7/64	.003	.041	.003	.032	.0120	.0094	.3436
1/8	.004	.053	.004	.042	.0156	.0123	.3927
9/64	.006	.067	.004	.053	.0198	.0155	.4418
5/32	.007	.083	.005	.065	.0244	.0192	.4909
11/64	.008	.100	.007	.079	.0295	.0232	.5400
3/16	.010	.120	.008	.094	.0352	.0276	.5891
13/64	.012	.140	.009	.110	.0413	.0324	.6381
7/32	.014	.163	.011	128	.0479	.0376	.6872
15/64	.016	.187	.012	.147	.0549	.0431	.7363
1/4	.018	.212	.014	.167	.0625	.0491	.7854
17/64	.020	.240	.016	.188	.0706	.0554	.8345
9/32	.022	.269	.018	.211	.0791	.0621	.8836
19/64	.025	.300	.020	.235	.0881	.0692	.9327
5/16	.028	.332	.022	.261	.0977	.0767	.9818
21/64	.031	.366	.024	.288	.1077	.0846	1.0308
11/32	.033	.402	.026	.316	.1182	.0928	1.0799
23/64	.037	.439	.029	.345	.1292	.1014	1.1290
3/8	.040	.478	.031	.376	.1406	.1104	1.1781
25/64	.043	.519	.034	.407	.1526	.1198	1.2272
13/32	.047	.561	.037	.441	.1650	.1296	1.2763
27/64	.050	.605	.040	.475	.1780	.1398	1.3254
7/16	.054	.651	.043	.511	.1914	.1503	1.3745
29/64	.058	.698	.046	.548	.2053	.1613	1.4235
15/32	.062	.747	.049	.587	.2197	.1726	1.4726
31/64	.066	.798	.052	.627	.2346	.1843	1.5217
1/2	.071	.850	.056	.668	.2500	.1963	1.5708
33/64	.075	.904	.060	.710	.2659	.2088	1.6199
17/32	.080	.960	.063	754	.2822	.2217	1.6690
35/64	.085	1.017	.067	.799	.2991	.2349	1.7181
9/16	.090	1.076	.070	.845	.3164	.2485	1.7672
37/64	.095	1.136	.074	.893	.3342	.2625	1.8162
19/32	.100	1.199	.078	.941	.3525	.2769	1.8653
39/64	.105	1.263	.083	992	.3713	.2916	1.9144
5/8	.111	1.328	.087	1.043	.3906	.3068	1.9635
41/64	.116	1.395	.091	1.096	.4104	.3223	2.0126
21/32	.122	1.464	.096	1.150	.4307	.3382	2.0617
43/64	.128	1.535	.100	1.205	.4514	.3545	2.1108
11/16	134	1.607	.105	1.262	.4727	.3712	2.1599
45/64	.140	1.681	.110	1.320	.4944	.3883	2.2089
23/32	.146	1.756	.115	1.380	.5166	.4057	2.2580
47/64	.153	1.834	.120	1.440	.5393	.4236	2.3071
3/4	.159	1.913	.125	1.502	.5625	.4418	2.3562
13/16	.187	2.245	.147	1.763	.6602	.5185	2.5526
7/8	.217	2.603	.170	2.044	.7656	.6013	2.7489
15/16	.249	2.988	.196	2.347	.8789	.6903	2.9453

1″ TO 3 15/16 — SQUARE AND ROUND BARS

WEIGHTS, AREAS AND CIRCUMFERENCE

Thickness or Diameter in Inches	Weight in Pounds				Area in Sq. Inches		Circumference
	Square		Round		Square	Round	
	One Inch Long	One Foot Long	One Inch Long	One Foot Long			
1″	.28	3.400	.22	2.670	1.0000	.7854	3.1416
1/16	.32	3.838	.25	3.015	1.1289	.8866	3.3380
1/8	.36	4.303	.28	3.380	1.2656	.9940	3.5343
3/16	.40	4.795	.31	3.766	1.4102	1.1075	3.7306
1/4	.44	5.313	.35	4.172	1.5625	1.2272	3.9270
5/16	.49	5.857	.38	4.600	1.7227	1.3530	4.1234
3/8	.54	6.428	.42	5.049	1.8906	1.4849	4.3197
7/16	.58	7.026	.46	5.518	2.0664	1.6230	4.5161
1/2	.64	7.650	.50	6.008	2.2500	1.7671	4.7124
9/16	.69	8.301	.54	6.519	2.4414	1.9175	4.9088
5/8	.75	8.978	.59	7.051	2.6406	2.0739	5.1051
11/16	.81	9.682	.63	7.604	2.8477	2.2365	5.3015
3/4	.87	10.41	.68	8.178	3.0625	2.4053	5.4978
13/16	.94	11.17	.73	8.773	3.2852	2.5802	5.6942
7/8	1.00	11.95	.78	9.388	3.5156	2.7612	5.8905
15/16	1.06	12.76	.84	10.02	3.7539	2.9483	6.0869
2″	1.13	13.60	.89	10.68	4.0000	3.1416	6.2832
1/16	1.21	14.46	.95	11.36	4.2539	3.3410	6.4796
1/8	1.28	15.35	1.01	12.06	4.5156	3.5466	6.6759
3/16	1.36	16.27	1.07	12.78	4.7852	3.7583	6.8723
1/4	1.43	17.21	1.13	13.52	5.0625	3.9761	7.0686
5/16	1.52	18.18	1.19	14.28	5.3477	4.2000	7.2650
3/8	1.60	19.18	1.26	15.06	5.6406	4.4301	7.4613
7/16	1.68	20.20	1.32	15.87	5.9414	4.6664	7.6577
1/2	1.77	21.25	1.39	16.69	6.2500	4.9087	7.8540
9/16	1.86	22.33	1.46	17.53	6.5664	5.1573	8.0504
5/8	1.95	23.43	1.54	18.40	6.8906	5.4119	8.2467
11/16	2.05	24.56	1.61	19.29	7.2227	5.6727	8.4431
3/4	2.14	25.71	1.69	20.19	7.5625	5.9396	8.6394
13/16	2.24	26.90	1.76	21.12	7.9102	6.2126	8.8358
7/8	2.34	28.10	1.84	22.07	8.2656	6.4918	9.0321
15/16	2.44	29.34	1.92	23.04	8.6289	6.7771	9.2285
3″	2.55	30.60	2.01	24.03	9.0000	7.0686	9.4248
1/16	2.66	31.89	2.09	25.05	9.3789	7.3662	9.6212
1/8	2.77	33.20	2.18	26.08	9.7656	7.6699	9.8175
3/16	2.88	34.55	2.26	27.13	10.160	7.9798	10.014
1/4	2.99	35.92	2.35	28.21	10.563	8.2958	10.210
5/16	3.11	37.31	2.44	29.30	10.973	8.6179	10.407
3/8	3.23	38.73	2.53	30.42	11.391	8.9462	10.603
7/16	3.35	40.18	2.63	31.55	11.816	9.2806	10.799
1/2	3.47	41.65	2.73	32.71	12.250	9.6211	10.996
9/16	3.60	43.15	2.82	33.89	12.691	9.9678	11.192
5/8	3.72	44.68	2.92	35.09	13.141	10.321	11.388
11/16	3.85	46.23	3.03	36.31	13.598	10.680	11.585
3/4	3.98	47.82	3.13	37.55	14.063	11.045	11.781
13/16	4.12	49.42	3.23	38.81	14.535	11.416	11.977
7/8	4.25	51.05	3.34	40.10	15.016	11.793	12.174
15/16	4.39	52.71	3.45	41.40	15.504	12.177	12.370

SQUARE AND ROUND BARS — 4″ TO 6 15/16

WEIGHTS, AREAS AND CIRCUMFERENCE

Thickness or Diameter in Inches	Weight in Pounds — Square — One Inch Long	Weight in Pounds — Square — One Foot Long	Weight in Pounds — Round — One Inch Long	Weight in Pounds — Round — One Foot Long	Area in Sq. Inches — Square	Area in Sq. Inches — Round	Circumference
4″	4.53	54.40	3.57	42.73	16.000	12.566	12.566
1/16	4.68	56.11	3.67	44.07	16.504	12.962	12.763
1/8	4.82	57.85	3.79	45.44	17.016	13.364	12.959
3/16	4.97	59.62	3.90	46.83	17.535	13.772	13.155
1/4	5.12	61.41	4.02	48.24	18.063	14.186	13.352
5/16	5.27	63.23	4.14	49.66	18.598	14.607	13.548
3/8	5.42	65.08	4.26	51.11	19.141	15.033	13.745
7/16	5.58	66.95	4.38	52.58	19.691	15.466	13.941
1/2	5.74	68.85	4.51	54.07	20.250	15.904	14.137
9/16	5.90	70.78	4.63	55.59	20.816	16.349	14.334
5/8	6.06	72.73	4.76	57.12	21.391	16.800	14.530
11/16	6.23	74.71	4.89	58.67	21.973	17.257	14.726
3/4	6.39	76.71	5.02	60.25	22.563	17.721	14.923
13/16	6.56	78.74	5.15	61.85	23.160	18.190	15.119
7/8	6.73	80.80	5.29	63.46	23.766	18.665	15.315
15/16	6.91	82.89	5.42	65.10	24.379	19.147	15.512
5″	7.08	85.00	5.56	66.76	25.000	19.635	15.708
1/16	7.26	87.14	5.70	68.44	25.629	20.129	15.904
1/8	7.44	89.30	5.84	70.14	26.266	20.629	16.101
3/16	7.62	91.49	5.99	71.86	26.910	21.135	16.297
1/4	7.81	93.71	6.13	73.60	27.563	21.648	16.493
5/16	8.00	95.96	6.28	75.37	28.223	22.166	16.690
3/8	8.19	98.23	6.43	77.15	28.891	22.691	16.886
7/16	8.38	100.5	6.58	78.95	29.566	23.221	17.082
1/2	8.57	102.9	6.73	80.78	30.250	23.758	17.279
9/16	8.77	105.2	6.88	82.62	30.941	24.301	17.475
5/8	8.96	107.6	7.04	84.49	31.641	24.851	17.672
11/16	9.16	110.0	7.20	86.38	32.348	25.406	17.868
3/4	9.37	112.4	7.36	88.29	33.063	25.967	18.064
13/16	9.57	114.9	7.52	90.22	33.785	26.535	18.261
7/8	9.78	117.4	7.68	92.17	34.516	27.109	18.457
15/16	9.99	119.9	7.84	94.14	35.254	27.688	18.653
6″	10.20	122.4	8.01	96.13	36.000	28.274	18.850
1/16	10.41	125.0	8.18	98.15	36.754	28.867	19.046
1/8	10.63	127.6	8.35	100.2	37.516	29.465	19.242
3/16	10.85	130.2	8.52	102.2	38.285	30.069	19.439
1/4	11.07	132.8	8.69	104.3	39.063	30.680	19.635
5/16	11.29	135.5	8.87	106.4	39.848	31.296	19.831
3/8	11.51	138.2	9.04	108.5	40.641	31.919	20.028
7/16	11.74	140.9	9.22	110.7	41.441	32.548	20.224
1/2	11.97	143.7	9.40	112.8	42.250	33.183	20.420
9/16	12.20	146.5	9.58	115.0	43.066	33.824	20.617
5/8	12.43	149.2	9.77	117.2	43.891	34.472	20.813
11/16	12.67	152.1	9.95	119.4	44.723	35.125	21.009
3/4	12.91	154.9	10.14	121.7	45.563	35.785	21.206
13/16	13.15	157.8	10.33	123.9	46.410	36.451	21.402
7/8	13.39	160.7	10.52	126.2	47.266	37.122	21.599
15/16	13.64	163.6	10.71	128.5	48.129	37.800	21.795

7″ TO 9 15/16 — SQUARE AND ROUND BARS

WEIGHTS, AREAS AND CIRCUMFERENCE

Thickness or Diameter in Inches	Weight in Pounds				Area in Sq. Inches		Circumference
	Square		Round				
	One Inch Long	One Foot Long	One Inch Long	One Foot Long	Square	Round	
7″	13.88	166.6	10.90	130.8	49.000	38.485	21.991
1/16	14.13	169.6	11.10	133.2	49.879	39.175	22.188
1/8	14.38	172.6	11.30	135.6	50.766	39.871	22.384
3/16	14.64	175.6	11.50	138.0	51.660	40.574	22.580
1/4	14.89	178.7	11.70	140.4	52.563	41.283	22.777
5/16	15.15	181.8	11.90	142.8	53.473	41.997	22.973
3/8	15.41	184.9	12.10	145.2	54.391	42.718	23.169
7/16	15.67	188.1	12.31	147.7	55.316	43.446	23.366
1/2	15.94	191.3	12.52	150.2	56.250	44.179	23.562
9/16	16.20	194.5	12.73	152.7	57.191	44.918	23.758
5/8	16.47	197.7	12.94	155.3	58.141	45.664	23.955
11/16	16.74	200.9	13.15	157.8	59.098	46.415	24.151
3/4	17.02	204.2	13.36	160.4	60.063	47.173	24.347
13/16	17.29	207.5	13.58	163.0	61.035	47.937	24.544
7/8	17.57	210.9	13.80	165.6	62.016	48.707	24.740
15/16	17.85	214.2	14.02	168.2	63.004	49.483	24.936
8″	18.11	217.6	14.24	170.9	64.000	50.266	25.133
1/16	18.42	221.0	14.46	173.6	65.004	51.054	25.329
1/8	18.70	224.5	14.69	176.3	66.016	51.849	25.526
3/16	18.99	227.9	14.92	179.0	67.035	52.649	25.722
1/4	19.28	231.4	15.14	181.8	68.063	53.456	25.918
5/16	19.58	234.9	15.38	184.5	69.098	54.269	26.115
3/8	19.87	238.5	15.61	187.3	70.141	55.088	26.311
7/16	20.17	242.1	15.84	190.1	71.191	55.914	26.507
1/2	20.47	245.7	16.08	192.9	72.250	56.745	26.704
9/16	20.77	249.3	16.31	195.8	73.316	57.583	26.900
5/8	21.08	252.9	16.55	198.6	74.391	58.426	27.096
11/16	21.38	256.6	16.79	201.5	75.473	59.276	27.293
3/4	21.69	260.3	17.04	204.4	76.563	60.132	27.489
13/16	22.00	264.0	17.28	207.4	77.660	60.994	27.685
7/8	22.31	267.8	17.53	210.3	78.766	61.863	27.882
15/16	22.63	271.6	17.77	213.3	79.879	62.737	28.078
9″	22.95	275.4	18.02	216.3	81.000	63.617	28.274
1/16	23.27	279.2	18.27	219.3	82.129	64.504	28.471
1/8	23.59	283.1	18.53	222.3	83.266	65.397	28.667
3/16	23.91	287.0	18.78	225.4	84.410	66.296	28.863
1/4	24.24	290.9	19.04	228.5	85.563	67.201	29.060
5/16	24.57	294.9	19.30	231.6	86.723	68.112	29.256
3/8	24.90	298.8	19.56	234.7	87.891	69.029	29.453
7/16	25.23	302.8	19.82	237.8	89.066	69.953	29.649
1/2	25.57	306.9	20.08	241.0	90.250	70.882	29.845
9/16	25.91	310.9	20.35	244.2	91.441	71.818	30.042
5/8	26.25	315.0	20.61	247.4	92.641	72.760	30.238
11/16	26.59	319.1	20.88	250.6	93.848	73.708	30.434
3/4	26.93	323.2	21.15	253.8	95.063	74.662	30.631
13/16	27.28	327.4	21.42	257.1	96.285	75.622	30.827
7/8	27.63	331.6	21.70	260.4	97.516	76.589	31.023
15/16	27.98	335.8	21.97	263.7	98.754	77.561	31.220

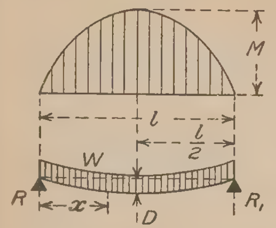
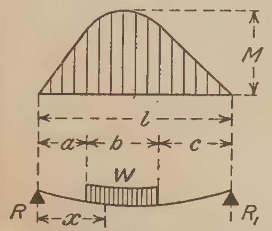
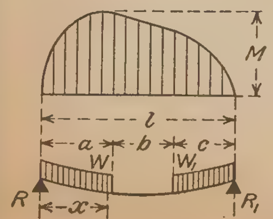
SQUARE AND ROUND BARS

WEIGHTS, AREAS AND CIRCUMFERENCE

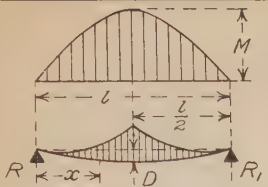
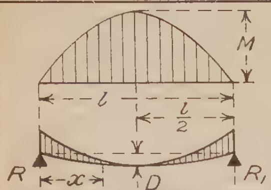
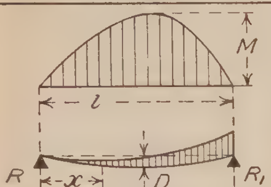
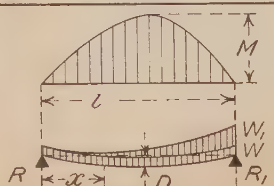
10″ TO 15¾

Thickness or Diameter in Inches	Weight in Pounds				Area in Sq. Inches		Circumference
	Square		Round		Square	Round	
	One Inch Long	One Foot Long	One Inch Long	One Foot Long			
10″	28.33	340.0	22.25	267.0	100.00	78.540	31.416
1/16	28.69	344.3	22.53	270.4	101.25	79.525	31.612
1/8	29.04	348.6	22.81	273.8	102.52	80.516	31.809
3/16	29.41	352.9	23.09	277.1	103.79	81.513	32.005
1/4	29.77	357.2	23.38	280.6	105.06	82.516	32.201
5/16	30.13	361.6	23.66	284.0	106.35	83.525	32.398
3/8	30.50	366.0	23.95	287.4	107.64	84.541	32.594
7/16	30.87	370.4	24.24	290.9	108.94	85.563	32.790
1/2	31.24	374.9	24.53	294.4	110.25	86.590	32.987
9/16	31.61	379.3	24.82	297.9	111.57	87.624	33.183
5/8	31.98	383.8	25.12	301.5	112.89	88.664	33.380
11/16	32.36	388.4	25.42	305.0	114.22	89.710	33.576
3/4	32.74	392.9	25.71	308.6	115.56	90.763	33.772
13/16	33.12	397.5	26.01	312.2	116.91	91.821	33.969
7/8	33.51	402.1	26.32	315.8	118.27	92.886	34.165
15/16	33.89	406.7	26.62	319.5	119.63	93.957	34.361
11″	34.28	411.4	26.92	323.1	121.00	95.033	34.558
1/16	34.67	416.1	27.23	326.8	122.38	96.116	34.754
1/8	35.06	420.8	27.54	330.5	123.77	97.206	34.950
3/16	35.46	425.5	27.85	334.3	125.16	98.301	35.147
1/4	35.86	430.3	28.16	338.0	126.56	99.402	35.343
5/16	36.26	435.1	28.48	341.7	127.97	100.51	35.539
3/8	36.66	439.9	28.79	345.5	129.39	101.62	35.736
7/16	37.06	444.8	29.11	349.3	130.82	102.74	35.932
1/2	37.47	449.7	29.43	353.2	132.25	103.87	36.128
9/16	37.88	454.6	29.75	357.0	133.69	105.00	36.325
5/8	38.29	459.5	30.07	360.9	135.14	106.14	36.521
11/16	38.70	464.4	30.39	364.8	136.60	107.28	36.717
3/4	39.12	469.4	30.72	368.7	138.06	108.43	36.914
13/16	39.53	474.4	31.04	372.6	139.54	109.59	37.110
7/8	39.95	479.5	31.38	376.6	141.02	110.75	37.307
15/16	40.37	484.5	31.71	380.5	142.50	111.92	37.503
12″	40.80	489.5	32.04	384.5	144.00	113.10	37.699
1/4	42.52	510.1	33.39	400.7	150.06	117.86	38.485
1/2	44.27	531.2	34.77	417.2	156.25	122.72	39.270
3/4	46.05	552.6	36.17	434.1	162.56	127.68	40.055
13″	47.88	574.5	37.60	451.2	169.00	132.73	40.841
1/4	49.74	596.8	39.06	468.8	175.56	137.89	41.626
1/2	51.63	619.6	40.55	486.6	182.25	143.14	42.412
3/4	53.56	642.7	42.07	504.8	189.06	148.49	43.197
14″	55.53	666.3	43.62	523.3	196.00	153.94	43.982
1/4	57.53	690.3	45.18	542.2	203.06	159.48	44.768
1/2	59.57	714.8	46.78	561.4	210.25	165.13	45.553
3/4	61.64	739.6	48.41	580.9	217.56	170.87	46.339
15″	63.75	764.9	50.06	600.7	225.00	176.71	47.124
1/4	65.89	790.6	51.75	620.9	232.56	182.65	47.909
1/2	68.07	816.8	53.46	641.5	240.25	188.69	48.695
3/4	70.28	843.3	55.20	662.3	248.06	194.83	49.480

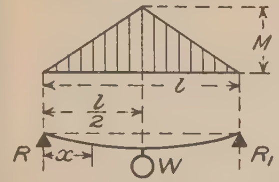
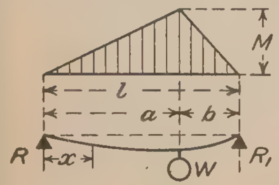
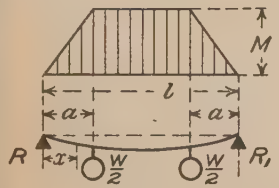
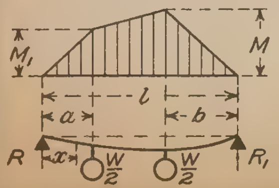
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS R AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM SUPPORTED BOTH ENDS. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$R = R_1 = V(max) = \frac{W}{2}$ At x $V = \frac{W}{2} - \frac{Wx}{l}$	At *center* $M(max) = \frac{Wl}{8}$ At x $M = \frac{Wx}{2l}\left(l - x\right)$	At *center* $D(max) = \frac{5}{384}\,\frac{Wl^3}{EI}$ At x $D = \frac{Wx}{24\,EIl}\left(l^3 - 2lx^2 + x^3\right)$
	BEAM SUPPORTED BOTH ENDS. CONTINUOUS LOAD, PARTIALLY DISTRIBUTED		
	$R = \frac{W(2c + b)}{2l}$ $R_1 = \frac{W(2a + b)}{2l}$ $V(max) = R$ when $a < c$, $= R_1$ when $a > c$ At x, when $x > a$, or $< (a + b)$ $V = \frac{W(2c + b)}{2l} - \frac{W}{b}\left(x - a\right)$	At x: when $x = a + \frac{Rb}{W}$ $M(max) = \frac{W(2c + b)\left[4al + b(2c + b)\right]}{8l^2}$ when $x < a$ or $= a$; $M = Rx$ when $x < (a+b)$ or $> a$ $M = Rx - \frac{W(x-a)^2}{2b}$ when $x > (a + b)$ $M = Rx - \frac{W(2x - 2a - b)}{2}$	
	BEAM SUPPORTED BOTH ENDS. TWO CONTINUOUS LOADS, DISTRIBUTED ONE AT EACH END		
	$R = \frac{W(2l - a) + W_1c}{2l}$ $R_1 = \frac{W_1(2l - c) + Wa}{2l}$ $V(max) = R$ when $W > W_1$ $= R_1$ when $W < W_1$ At x_1 when $x < a$ $V = R - \frac{Wx}{a}$	At x: when $Wa > W_1c$ when $x = \frac{2Wal - Wa^2 + W_1ca}{2Wl}$ $M(max) = \frac{R^2a}{2W}$ when $x < a$ $M = Rx - \frac{Wx^2}{2a}$ when $x > a$ $M = Rx - \frac{W(2x - a)}{2}$	

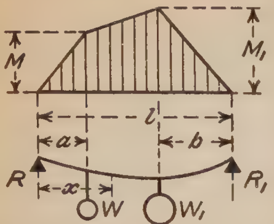
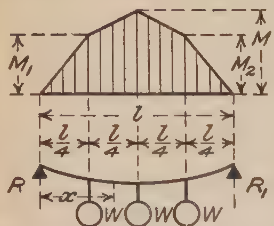
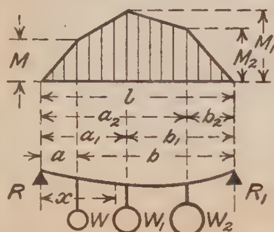
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM SUPPORTED BOTH ENDS. CONTINUOUS LOAD, INCREASING UNIFORMLY TO CENTER		
	$R = R_1 = V\,(max) = \frac{W}{2}$ At x $V = \frac{W}{2} - \frac{2\,Wx^2}{l^2}$	At *center* $M\,(max) = \frac{Wl}{6}$ At x $M = Wx\left(\frac{1}{2} - \frac{2x^2}{3\,l^2}\right)$	At *center* $D\,(max) = \frac{Wl^3}{60\,EI}$ At x $D = \frac{Wx}{6\,EIl^2}\left(\frac{l^2x^2}{2} - \frac{x^4}{5} - \frac{5\,l^4}{16}\right)$
	BEAM SUPPORTED BOTH ENDS. CONTINUOUS LOAD, DECREASING UNIFORMLY TO CENTER		
	$R = R_1 = V\,(max) = \frac{W}{2}$ At x $V = \frac{W}{2\,l^2}\left(l - 2\,x\right)^2$	At *center* $M\,(max) = \frac{Wl}{12}$ At x $M = Wx\left(\frac{1}{2} - \frac{x}{l} + \frac{2x^2}{3\,l^2}\right)$	At *center* $D\,(max) = \frac{3\,Wl^3}{320\,EI}$
	BEAM SUPPORTED BOTH ENDS. CONTINUOUS LOAD, INCREASING UNIFORMLY TO ONE END		
	$R = \frac{W}{3}$ $R_1 = V\,(max) = \frac{2\,W}{3}$ At x $V = \frac{W}{3} - \frac{Wx^2}{l^2}$	At x: when $x = \frac{l\sqrt{3}}{3}$ $M\,(max) = \frac{2\,Wl}{9\sqrt{3}}$ At x $M = \frac{Wx}{3}\left(1 - \frac{x^2}{l^2}\right)$	At x: when $x = l\sqrt{1 - \sqrt{\frac{8}{15}}} = .519\,l$ $D\,(max) = \frac{.013044\,Wl^3}{EI}$ At x $D = \frac{Wx}{6\,EIl^2}\left(\frac{x^4}{10} - \frac{l^2x^2}{3} + \frac{7\,l^4}{30}\right)$
	BEAM SUPPORTED BOTH ENDS. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED, PLUS LOAD INCREASING UNIFORMLY TO ONE END		
	$R = \frac{W}{2} + \frac{W_1}{3}$ $R_1 = V\,(max) = \frac{W}{2} + \frac{2\,W_1}{3}$ At x $V = \frac{W}{2} - \frac{Wx}{l} + \frac{W_1}{3} - \frac{W_1x^2}{l^2}$	At x: when $x = 0.5\,l$ to $0.577\,l$ $M\,(max) = \left(W + \frac{W_1}{2}\right)\frac{l}{8}$ *approx.* At x $M = \frac{Wx}{2\,l}\left(l - x\right) + \frac{W_1x}{3\,l^2}\left(l^2 - x^2\right)$	At x: when $x = .5\,l$ *approx.* $D\,(max) = \frac{5\,Wl^3}{384\,EI} + \frac{.013044\,Wl^3}{EI}$

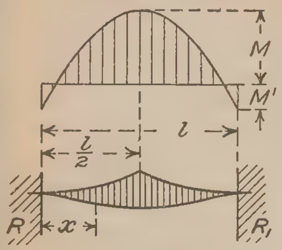
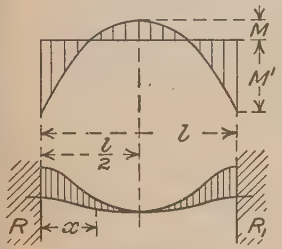
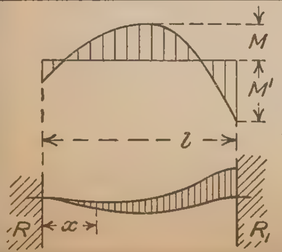
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM SUPPORTED BOTH ENDS. CONCENTRATED LOAD AT CENTER		
	$R = R_1 = V(max) = \frac{W}{2}$ At x $V = \frac{W}{2}$	At *center* $M(max) = \frac{Wl}{4}$ At x $M = \frac{Wx}{2}$	At *center* $D(max) = \frac{Wl^3}{48EI}$ When $x < \frac{l}{2}$ At x $D = \frac{W}{48EI}(3l^2x - 4x^3)$
	BEAM SUPPORTED BOTH ENDS. CONCENTRATED LOAD NEAR ONE END		
	$R = \frac{Wb}{l}$ $R_1 = \frac{Wa}{l}$ $V(max) = R$ when $a < b$ and R_1 when $a > b$ At x $V = \frac{Wb}{l}$	At *point of load* $M(max) = \frac{Wab}{l}$ At x: when $x < a$ $M = \frac{Wbx}{l}$	At x: when $x = \sqrt{a(a+2b)} \div 3$ and $a > b$ $D(max) = Wab(a+2b)\sqrt{3a(a+2b)} \div 27EIl$ At x: when $x < a$ $D = \frac{Wbx}{6EIl}\left[2l(l-x) - b^2 - (l-x)^2\right]$ At x: when $x > a$ $D = \frac{Wa(l-x)}{6EIl}\left[2lb - b^2 - (l-x)^2\right]$
	BEAM SUPPORTED BOTH ENDS. TWO EQUAL CONCENTRATED LOADS, SYMMETRICALLY DISTRIBUTED		
	$R = R_1 = V(max) = \frac{W}{2}$ At x: when $x < a$ $V = \frac{W}{2}$ At x: when $x > a$ and $< (l-a)$ $V = 0$	At and between *loads* $M(max) = \frac{Wa}{2}$ At x $M = \frac{Wx}{2}$	At *center* $D(max) = \frac{Wa}{12EI}\left(\frac{3l^2}{4} - a^2\right)$ At x: when $x < a$ $D = \frac{Wx}{12EI}(3la - 3a^2 - x^2)$ At x: when $x > a$ and $< (l-a)$ $D = \frac{Wa}{12EI}(3lx - 3x^2 - a^2)$
	BEAM SUPPORTED BOTH ENDS. TWO EQUAL CONCENTRATED LOADS, UNEQUALLY DISTRIBUTED		
	When $a < b$ $R = V(max) = \frac{W}{2l}(l - a + b)$ $R_1 = \frac{W}{2l}(l - b + a)$ $V(max) = R$ when $a < b$ $= R_1$ when $a > b$	At x: when $x = l - b$ when $b > a$ $M(max) = \frac{Wb}{2l}(l + a - b)$ At x: when $x = a$ $M = \frac{Wa}{2l}(l - a + b)$ At x: when $x > a$ or $< (l-b)$ $M = Rx - \frac{W}{2}(x - a)$	

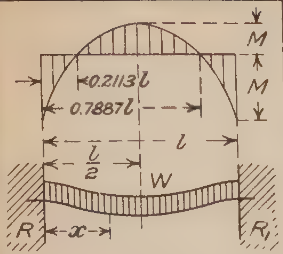
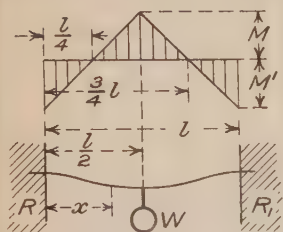
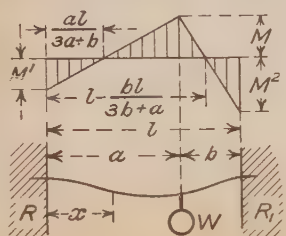
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM SUPPORTED BOTH ENDS. TWO UNEQUAL CONCENTRATED LOADS, UNEQUALLY DISTRIBUTED		
	$R = \frac{1}{l}\left[W(l-a) + W_1 b\right]$ $R_1 = \frac{1}{l}\left[Wa + W_1(l-b)\right]$ $V(max)$ = *Maximum Reaction* At x: when $x > a$ and $< (l-b)$ $V = R - W$	At point of load W $M = \frac{a}{l}\left[W(l-a) + W_1 b\right]$ At point of load W_1 $M_1 = \frac{b}{l}\left[Wa + W_1(l-b)\right]$ At x: when $x > a$ or $< (l-b)$ $M = W\frac{a}{l}(l-x) + W_1\frac{bx}{l}$	
	BEAM SUPPORTED BOTH ENDS. THREE EQUAL CONCENTRATED LOADS, SYMMETRICALLY DISTRIBUTED		
	$R = R_1 = V(max) = \frac{3W}{2}$ At x: when $x < \frac{l}{4}$ $V = \frac{3W}{2}$ At x: when $x > \frac{l}{4}$ and $< \frac{l}{2}$ $V = \frac{W}{2}$	*At center* $M(max) = \frac{Wl}{2}$ At x: when $x = \frac{l}{4}$ $M_1 = \frac{3Wl}{8}$	*At center* $D(max) = \frac{19}{384}\frac{Wl^3}{EI}$
	BEAM SUPPORTED BOTH ENDS. THREE UNEQUAL CONCENTRATED LOADS, UNEQUALLY DISTRIBUTED		
	$R = \frac{Wb + W_1 b_1 + W_2 b_2}{l}$ $R_1 = \frac{Wa + W_1 a_1 + W_2 a_2}{l}$ $V(max)$ = *Maximum Reaction* At x: when $x > a$ and $< a_1$ $V = R - W$ At x: when $x > a_1$ and $< a_2$ $V = R - W - W_1$	At x: when $x = a$ $M = Ra$ At x: when $x = a_1$ $M_1 = Ra_1 - W(a_1 - a)$ At x: when $x = a_2$ $M_2 = Ra_2 - W(a_2 - a) - W_1(a_2 - a_1)$ $M(max) = M$ when $W = R$ or $> R$ $M(max) = M_1$ when $\begin{cases} W_1 + W = R \text{ or } > R \\ W_1 + W_2 = R_1 \text{ or } > R_1 \end{cases}$ $M(max) = M_2$ when $W_2 = R_1$ or $> R_1$	

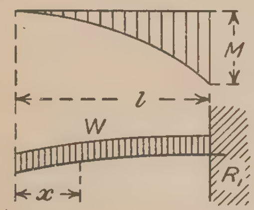
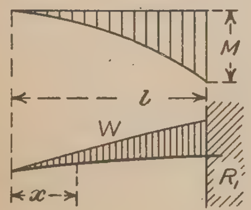
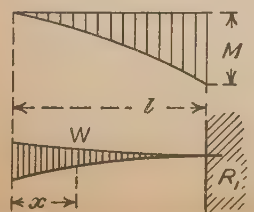
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM FIXED AT BOTH ENDS. CONTINUOUS LOAD, INCREASING UNIFORMLY TO CENTER		
	$R = R_1 = V\,(max) = \frac{W}{2}$ At x $V = \frac{W}{2} - \frac{2\,Wx^2}{l^2}$	At *center* $M\,(max) = \frac{Wl}{16}$ At *support* $M^1\,(max) = \frac{5\,Wl}{48}$ At x $M = M^1 + \frac{Wx}{2} - \frac{2\,Wx^3}{3\,l^2}$	
	BEAM FIXED AT BOTH ENDS. CONTINUOUS LOAD, DECREASING UNIFORMLY TO CENTER		
	$R = R_1 = V\,(max) = \frac{W}{2}$ At x $V = \frac{W}{2\,l^2}\left(l - 2x\right)^2$	At *center* $M\,(max) = \frac{Wl}{48}$ At *support* $M^1\,(max) = \frac{Wl}{16}$	
	BEAM FIXED AT BOTH ENDS. CONTINUOUS LOAD, INCREASING UNIFORMLY TO ONE END		
	$R = \frac{3\,W}{10}$ $R_1 = V\,(max) = \frac{7\,W}{10}$ At x $V = \frac{3\,W}{10} - \frac{W\,x^2}{l^2}$	At x: when $x = .548\,l$ $M\,(max) = .043\,Wl$ At *support* $M^1 = \frac{Wl}{10}$ At x $M = \frac{3\,Wx}{10} - \frac{Wl}{15} - \frac{Wx^3}{3\,l^2}$	

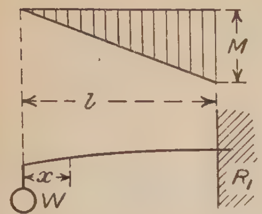
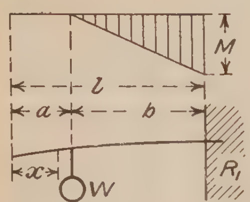
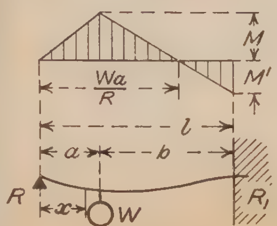
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM FIXED AT BOTH ENDS. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$R = R_1 = V\,(max) = \frac{W}{2}$ At x $V = \frac{W}{2} - \frac{Wx}{l}$	At *center* $M\,(max) = \frac{Wl}{24}$ At *supports* $M^1\,(max) = \frac{Wl}{12}$ At x $M = \frac{W}{2l}\left(-\frac{l^2}{6} + lx - x^2\right)$	At *center* $D\,(max) = \frac{1}{384}\,\frac{Wl^3}{EI}$ At x $D = \frac{Wx^2}{24\,EIl}\left(l^2 - 2\,lx + x^2\right)$
	BEAM FIXED AT BOTH ENDS. CONCENTRATED LOAD, AT CENTER		
	$R = R_1 = V\,(max) = \frac{W}{2}$ At x $V = \frac{W}{2}$	At *center* $M\,(max) = \frac{Wl}{8}$ At *supports* $M^1\,(max) = \frac{Wl}{8}$ At x: when $x < \frac{l}{2}$ $M = \frac{W}{2}\left(x - \frac{l}{4}\right)$	At *center* $D\,(max) = \frac{1}{192}\,\frac{Wl^3}{EI}$ At x $D = \frac{Wx^2}{6\,EI}\left(-\frac{1}{2}x + \frac{3}{8}l\right)$
	BEAM FIXED AT BOTH ENDS. CONCENTRATED LOAD, NEAR ONE END		
	$R = W\left(\frac{b^2\,(3\,a + b)}{l^3}\right)$ $R_1 = W\left(\frac{a^2\,(3\,b + a)}{l^3}\right)$ $V\,(max) = R$ when $a < b$ $= R_1$ when $a > b$ At x: when $x < a$ $V = R$	At *support R* $M^1\left(\begin{array}{c}\textit{max. neg. mom.}\\ \text{when } b > a\end{array}\right) = -W\frac{ab^2}{l^2}$ At *support* R_1 $M^2\left(\begin{array}{c}\textit{max. neg. mom.}\\ \text{when } a > b\end{array}\right) = -W\frac{a^2b}{l^2}$ At point of load $M\,(max) = Ra + M^1 = Ra - W\frac{ab^2}{l^2}$ At x $M = Rx - W\frac{ab^2}{l^2}$	At x: when $x = \frac{2\,al}{3\,a + b}$ and $a > b$ $D\,(max) = \frac{2\,W\,a^3b^2}{3\,EI\,(3\,a + b)^2}$ when $x < a$ $D = \frac{Wb^2x^2}{6\,EIl^3}\left(3al - 3ax - bx\right)$

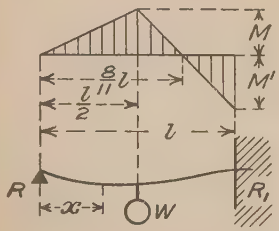
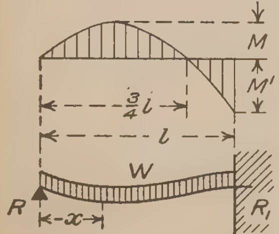
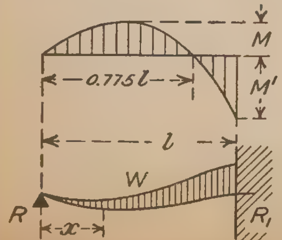
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM FIXED AT ONE END (CANTILEVER). CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$R_1 = V(max) = W$ At x $V = \frac{Wx}{l}$	At *fixed end* $M\ (max) = \frac{Wl}{2}$ At x $M = \frac{Wx^2}{2l}$	At *free end* $D\ (max) = \frac{Wl^3}{8EI}$ At x $D = \frac{W}{24EIl}\left(x^4 - 4l^3x + 3l^4\right)$
	BEAM FIXED AT ONE END (CANTILEVER). CONTINUOUS LOAD, INCREASING UNIFORMLY TO FIXED END		
	$R_1 = V(max) = W$ At x $V = \frac{Wx^2}{l^2}$	At *fixed end* $M\ (max) = \frac{Wl}{3}$ At x $M = \frac{Wx^3}{3l^2}$	At *free end* $D\ (max) = \frac{Wl^3}{15EI}$ At x $D = \frac{W}{60EIl^2}\left(x^5 - 5l^4x + 4l^5\right)$
	BEAM FIXED AT ONE END (CANTILEVER). CONTINUOUS LOAD, INCREASING UNIFORMLY TO FREE END		
	$R_1 = V(max) = W$ At x $V = \frac{Wx}{l^2}\left(2l - x\right)$	At *fixed end* $M\ (max) = \frac{2Wl}{3}$ At x $M = \frac{Wx^2}{3l^2}\left(3l - x\right)$	At *free end* $D\ (max) = \frac{11Wl^3}{60EI}$

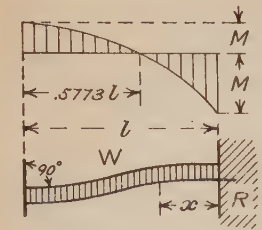
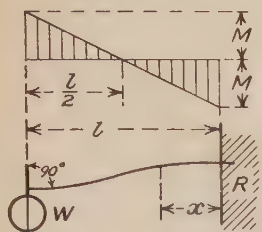
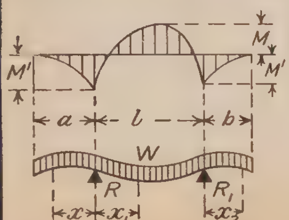
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM FIXED AT ONE END (CANTILEVER). CONCENTRATED LOAD AT FREE END		
	$R_1 = V\,(max) = W$ At x $V = W$	At *fixed end* $M\,(max) = Wl$ At x $M = Wx$	At *free end* $D\,(max) = \frac{Wl^3}{3\,EI}$ At x $D = \frac{W}{6\,EI}\left(2\,l^3 - 3\,l^2x + x^3\right)$
	BEAM FIXED AT ONE END (CANTILEVER). CONCENTRATED LOAD AT ANY POINT		
	$R_1 = V\,(max) = W$ At x: when $x > a$ $V = W$ At x: when $x < a$ $V = 0$	At *fixed end* $M\,(max) = Wb$ At x: when $x > a$ $M = W\,(x - a)$	At *free end* $D\,(max) = \frac{Wl^3}{6\,EI}\left[2 - \frac{3\,a}{l} + \left(\frac{a}{l}\right)^3\right]$ At *point of load* $D = \frac{W}{3\,EI}\left(l - a\right)^3$ At x: when $x > a$ $D = \frac{W}{6\,EI}\left(-3\,al^2 + 2\,l^3 + x^3 - 3\,ax^2 - 3\,l^2x + 6\,alx\right)$
	BEAM FIXED AT ONE END, SUPPORTED AT OTHER. CONCENTRATED LOAD AT ANY POINT		
	$R = W\left(\frac{3\,b^2l - b^3}{2\,l^3}\right)$ $R_1 = W\left(\frac{3\,al^2 - a^3}{2\,l^3}\right)$ At x when $x < a$ $V = R$ At x when $x > a$ $V = R - W$	At *point of load* $M\,(max) = Wa\left(\frac{3b^2l - b^3}{2\,l^3}\right)$ At *fixed end* $M^1\,(max) = Wl\left(\frac{3b^2l - b^3}{2\,l^3}\right) - W(l - a)$ At x: when $x < a$ $M = Wx\left(\frac{3b^2l - b^3}{2\,l^3}\right)$ At x: when $x > a$ $M = Wx\left(\frac{3b^2l - b^3}{2\,l^3}\right) - W(x - a)$	At x: when $x = a = .414\,l$ $D\,(max) = .0098\,\frac{Wl^3}{EI}$ At x: when $x < a$ $D = \frac{1}{6\,EI}\left[3\,Rl^2x - Rx^3 - 3\,W\,(l - a)^2\,x\right]$ At x: when $x > a$ $D = \frac{1}{6\,EI}\left[R_1\,(2\,l^3 - 3\,l^2x + x^3) - 3\,Wa\,(l - x)^2\right]$

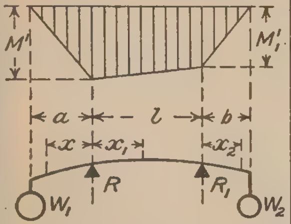
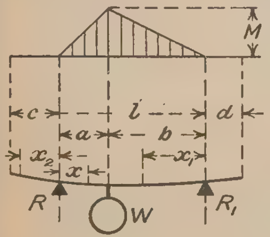
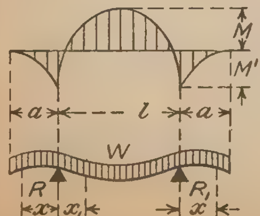
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM FIXED AT ONE END, SUPPORTED AT OTHER. CONCENTRATED LOAD, AT CENTER		
	$R = \frac{5}{16} W$ $R_1 = V(max) = \frac{11}{16} W$	At *center* $M\ (max) = \frac{5}{32} Wl$ At *fixed end* $M^1\ (max) = \frac{3}{16} Wl$ At x: when $x < l/2$ $M = \frac{5}{16} Wx$ At x: when $x > l/2$ $M = \frac{1}{2} Wl - \frac{11}{16} Wx$	At x: when $x = .4472\ l$ $D\ (max) = .00932 \frac{Wl^3}{EI}$ At x: when $x < l/2$ $D = \frac{Wx}{96\ EI}\left(5x^2 - 3\ l^2\right)$ At x: when $x > l/2$ $D = \frac{W}{96\ EI}\left[-2\ l^3 + 15\ l^2x - 24\ lx^2 + 11x^3\right]$
	BEAM FIXED AT ONE END, SUPPORTED AT OTHER. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$R = \frac{3}{8} W$ $R_1 = V(max) = \frac{5}{8} W$ At x $V = \frac{3}{8} W - \frac{Wx}{l}$	At x: when $x = \frac{3}{8} l$ $M\ (max) = \frac{9}{128} Wl$ At *fixed end* $M^1\ (max) = \frac{1}{8} Wl$ At x $M = \frac{Wx}{l}\left(\frac{3}{8} l - \frac{1}{2} x\right)$	At x: when $x = .4215\ l$ $D\ (max) = .0054 \frac{Wl^3}{EI}$ At x $D = \frac{Wx}{48\ EIl}\left[-3\ lx^2 + 2x^3 + l^3\right]$
	BEAM FIXED AT ONE END, SUPPORTED AT OTHER. CONTINUOUS LOAD, INCREASING UNIFORMLY TO FIXED END		
	$R = \frac{1}{5} W$ $R_1 = V(max) = \frac{4}{5} W$ At x $V = \frac{W}{5} - \frac{Wx^2}{l^2}$	At x: when $x = .4474\ l$ $M\ (max) = .06\ Wl$ At *fixed end* $M^1\ (max) = \frac{2\ Wl}{15} = .1333\ Wl$ At x $M = \frac{Wx}{5} - \frac{Wx^3}{3\ l^2}$	

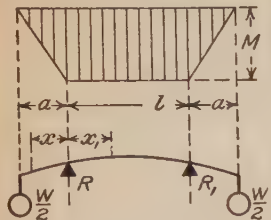
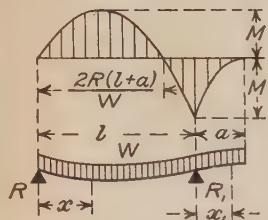
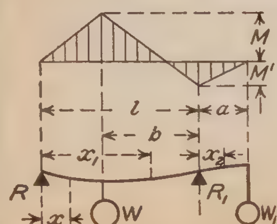
GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM FIXED AT ONE END, FREE BUT GUIDED AT OTHER. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$R = V(max) = W$ At x $V = \frac{W(l-x)}{l}$	At *fixed end* $M(max) = \frac{Wl}{3}$ At *free end* $M^1 = \frac{Wl}{6}$	At *free end* $D(max) = \frac{Wl^3}{24\,EI}$ At x $D = \frac{Wx^2}{24\,EIl}\left(2l - x\right)^2$
	BEAM FIXED AT ONE END, FREE BUT GUIDED AT OTHER. CONCENTRATED LOAD, AT GUIDED END		
	$R = V(max) = W$ At x $V = W$	At *fixed end* $M(max) = \frac{Wl}{2}$ At *free end* $M^1 = \frac{Wl}{2}$	At *free end* $D(max) = \frac{Wl^3}{12\,EI}$ At x $D = \frac{Wx^2}{12\,EI}\left(3l - 2x\right)$
	BEAM OVERHANGING BOTH SUPPORTS, UNSYMMETRICALLY PLACED. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$\frac{W}{a+l+b} = w =$ *load per unit of length* $R = w\left[(a+l)^2 - b^2\right] \div 2l$ $R_1 = w\left[(b+l)^2 - a^2\right] \div 2l$ $V(max) = wa$ or $R - wa$ At x: when $x < a$ $V = w(a-x)$ At x_1: when $x_1 < l$ $V = R - w(a + x_1)$ At x_2: when $x_2 < b$ $V = w(b - x_2)$	At x_1: when $x_1 = \frac{R}{w} - a$ $M(max) = R\left(\frac{R}{2w} - a\right)$ At R $M^1 = \frac{1}{2}wa^2$ At R_1 $M^1 = \frac{1}{2}wb^2$ At x: when $x < a$ $M = \frac{1}{2}w(a-x)^2$ At x_1: when $x_1 < l$ $M = \frac{1}{2}w(a+x_1)^2 - Rx_1$ At x_2: when $x_2 < b$ $M = \frac{1}{2}w(b-x_2)^2$	

GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM OVERHANGING BOTH SUPPORTS, UNSYMMETRICALLY PLACED. TWO CONCENTRATED LOADS AT ENDS		
	$R = \frac{W_1 a - W_2 b}{l} + W_1$ $R_1 = \frac{W_2 b - W_1 a}{l} + W_2$ At x: when $x < a$ $V = W_1$ At x_1: when $x_1 < l$ $V = W_1 - R$ At x_2: when $x_2 < b$ $V = W_2$	At R $M = W_1 a$ At R_1 $M = W_2 b$ At x: when $x < a$ $M = W_1 (a - x)$ At x_1: when $x_1 < l$ $M = W_1 a + (W_1 - R) x_1$ At x_2: when $x_2 < b$ $M = W_2 (b - x_2)$	
	BEAM OVERHANGING BOTH SUPPORTS, UNSYMMETRICALLY PLACED. CONCENTRATED LOAD AT ANY POINT		
	$R = \frac{W b}{l}$ $R_1 = \frac{W a}{l}$ $V\ (max) = R$ when $a < b$ At x: when $x < a$ $V = R$ At x_1: when $x_1 < b$ $V = R_1$	At *point of load* $M\ (max) = \frac{Wab}{l}$ At x: when $x < a$ $M = \frac{Wbx}{l}$ At x_1: when $x_1 < b$ $M = \frac{Wb}{l}\left(l - x_1\right) - W(b - x_1)$	At x_1: when $x_1 = b\sqrt{\frac{1}{3} + \frac{2a}{3b}}$ $D\ (max) = \frac{Wax_1^3}{3\,EIl}$ At x_2: when $x_2 = c$ $D = \frac{Wabc}{6\,EIl}\left(l + b\right)$ At x_1: when $x_1 = d$ $D = \frac{Wabd}{6\,EIl}\left(l + a\right)$
	BEAM OVERHANGING BOTH SUPPORTS, SYMMETRICALLY PLACED. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$R = R_1 = \frac{W}{2}$ $V\ (max) = \frac{Wa}{l + 2a}$ or $\frac{Wl}{2\,(l + 2a)}$	At *center* $M = \frac{W\,(l - 2a)}{8}$ At *supports* $M^1 = \frac{Wa^2}{2\,(l + 2a)}$ At x: when $x < a$ $M = \frac{W}{2\,(l + 2a)}\left(a - x\right)^2$ At x_1: when $x_1 < l$ $M = \frac{W}{2\,(l + 2a)}\left(a + x_1\right)^2 - Rx_1$	

GENERAL FORMULAE FOR BEAMS UNDER VARIOUS LOADING CONDITIONS

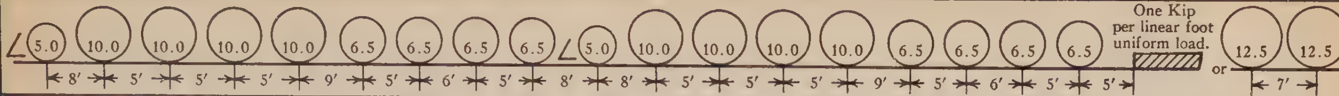
LOADING DIAGRAM	REACTIONS AND SHEAR V	BENDING MOMENT M	DEFLECTION D
	BEAM OVERHANGING BOTH SUPPORTS, SYMMETRICALLY PLACED. TWO EQUAL CONCENTRATED LOADS AT ENDS		
	$R = R_1 = V\,(max) = \frac{W}{2}$ At x: when $x < a$ $V = \frac{W}{2}$	At x_1: when $x_1 < l$ $M\,(max) = \frac{Wa}{2}$ At x: when $x < a$ $M = \frac{W}{2}(a - x)$	At *free ends* $D = \frac{Wa^2(3\,l + 2\,a)}{12\,EI}$ At *center* $D = \frac{Wal^2}{16\,EI}$
	BEAM OVERHANGING ONE SUPPORT. CONTINUOUS LOAD, UNIFORMLY DISTRIBUTED		
	$R = \frac{Wl}{2\,(l+a)} - \frac{Wa^2}{2\,l\,(l+a)}$ $R_1 = \frac{Wl}{2\,(l+a)} + \frac{Wa}{l+a} + \frac{Wa^2}{2\,l\,(l+a)}$ At x: when $x < l$ $V = R - \frac{Wx}{l+a}$ At x_1: when $x_1 < a$ $V = \frac{W}{l+a}(a - x_1)$	At x: when $x = \frac{1}{2}\left(l - \frac{a^2}{l}\right)$ $M\,(max) = \frac{R^2\,(l+a)}{2\,W}$ At x: when $x = l$ $M^1\,(max) = \frac{Wa^2}{2\,(l+a)}$ At x $M = Rx - \frac{Wx^2}{2\,(l+a)}$ At x_1 $M = \frac{W\,(a - x_1)^2}{2\,(l+a)}$	At x $D = \frac{1}{24\,EI}\left[4\,R\,(x^3 - l^2x) - \frac{W}{l+a}(x^4 - l^3x)\right]$ At x_1 $D = \frac{1}{24\,EI}\left[\frac{W}{l+a}\left(6a^2x_1^2 - 4ax_1^3 + 3\,l^3x_1 + x_1^4\right) - 8Rl^2x_1\right]$
	BEAM OVERHANGING ONE SUPPORT. CONCENTRATED LOADS AT FREE END AND BETWEEN SUPPORTS		
	$R = \frac{Wb - W_1a}{l}$ $R_1 = \frac{W\,(l-b) + W_1\,(a+l)}{l}$ At x: when $x < (l - b)$ $V = R$ At x_1: when $x_1 > (l - b)$ and $< l$ $V = R - W$ At x_2: when $x_2 < a$ $V = W_1$	At x: when $x < (l - b)$ $M = Rx$ At x_1: when $x_1 > (l - b)$ and $< l$ $M = Rx_1 - W\,(b + x_1 - l)$ At x_2 $M = W_1\,(a - x_2)$	

MOMENTS IN FOOT-KIPS FOR CLASS E-10 ENGINE LOADING ONE TRACK OF TWO RAILS

Wheel Numbers		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	One Kip per linear foot uniform load.
Axle Loads		5.0	10.0	10.0	10.0	10.0	6.5	6.5	6.5	6.5	5.0	10.0	10.0	10.0	10.0	6.5	6.5	6.5	6.5	
Spacing in feet		8	5	5	5	9	5	6	5	8	8	5	5	5	9	5	6	5	5	
Totals from end of train	Kips	142.0	137.0	127.0	117.0	107.0	97.0	90.5	84.0	77.5	71.0	66.0	56.0	46.0	36.0	26.0	19.5	13.0	6.5	0
	Feet	109	101	96	91	86	77	72	66	61	53	45	40	35	30	21	16	10	5	0
Moments of wheel Loads about	End of Train	8182.0	7637.0	6627.0	5667.0	4757.0	3897.0	3396.5	2928.5	2499.5	2103.0	1838.0	1388.0	988.0	638.0	338.0	201.5	97.5	32.5	
Wheel Number	18	7472.0	6952.0	5992.0	5082.1	4222.0	3412.0	2944.0	2508.5	2112.0	1748.0	1508.0	1108.0	758.0	458.0	208.0	104.2	32.5		
	17	6794.5	6299.5	5389.2	4529.5	3719.5	2959.5	2524.0	2121.0	1757.0	1425.5	1210.5	860.5	560.5	310.5	110.5	39.0	32.5		
	16	6020.5	5555.6	4705.5	3905.5	3155.6	2455.5	2059.0	1695.0	1370.0	1077.5	892.5	602.5	362.5	172.5	32.5	39.0	110.5		
	15	5408.0	4968.0	4168.0	3418.0	2718.0	2068.0	1704.0	1372.5	1080.0	820.0	660.0	420.0	230.0	90.0	32.5	104.0	208.0		
	14	4364.0	3969.0	3259.0	2599.0	1989.0	1429.0	1123.5	850.5	616.5	415.0	300.0	150.0	50.0	58.5	149.5	279.5	442.0		
	13	3834.0	3464.0	2804.0	2194.0	1634.0	1124.0	851.0	610.5	409.0	240.0	150.0	50.0	50.0	141.0	264.5	427.0	622.0		
	12	3354.0	3009.0	2399.0	1839.0	1329.0	869.0	628.5	420.5	251.5	115.0	50.0	50.0	150.0	273.5	429.5	624.5	852.0		
	11	2924.0	2604.0	2044.0	1534.0	1074.0	664.0	456.0	280.5	144.0	40.0	50.0	150.0	300.0	456.0	644.5	872.0	1132.0		
	10	2316.0	2036.0	1556.0	1126.0	746.0	416.0	260.0	136.5	52.0	80.0	210.0	390.0	620.0	828.0	1068.5	1348.0	1660.0		
	9	1748.0	1508.0	1108.0	758.0	458.0	208.0	104.0	32.5	40.0	200.0	410.0	670.0	980.0	1240.0	1532.5	1864.0	2228.0		
	8	1425.5	1210.5	860.5	560.5	310.5	110.5	39.0	32.5	97.5	307.5	567.5	877.5	1237.5	1530.0	1855.0	2219.0	2615.5		
	7	1077.2	892.5	602.5	362.5	172.5	32.5	39.0	110.5	205.5	475.5	795.5	1165.5	1585.5	1917.0	2281.0	2684.0	3119.5		
	6	820.0	660.0	420.0	230.0	90.0	32.5	104.0	208.0	328.0	648.0	1018.0	1438.0	1908.0	2272.0	2668.5	3104.0	3572.0		
	5	415.0	300.0	150.0	50.0	58.5	149.5	279.5	442.0	607.0	1017.0	1477.0	1987.0	2547.0	2969.5	3424.5	3918.5	4445.0		
	4	240.0	150.0	50.0	50.0	141.0	264.5	427.0	622.0	812.0	1272.0	1782.0	2342.0	2952.0	3407.0	3394.5	4421.0	4980.0		
	3	115.0	50.0	50.0	150.0	273.5	429.5	624.5	852.0	1067.0	1577.0	2137.0	2747.0	3407.0	3894.5	4414.4	4973.5	5565.0		
	2	40.0	50.0	150.0	300.0	456.0	644.5	872.0	1132.0	1372.0	1932.0	2542.0	3202.0	3912.0	4432.0	4984.5	5576.0	6200.0		
	1	80.0	210.0	390.0	620.0	828.0	1068.5	1348.0	1660.0	1940.0	2580.0	3270.0	4010.0	4800.0	5372.0	5976.5	6620.0	7296.0		
Totals from wheel No. 1	Kips	5.0	15.0	25.0	35.0	45.0	51.5	58.0	64.5	71.0	76.0	86.0	96.0	106.0	116.0	122.5	129.0	135.5	142.0	142.0
	Feet	0	8	13	18	23	32	37	43	48	56	64	69	74	79	88	93	99	104	109

For E 40 loading multiply Moments tabulated above by 4; for E 50 loading multiply by 5; for E 60 loading multiply by 6.

MAXIMUM MOMENTS, SHEARS, AND REACTIONS FOR CLASS E-10 ENGINE LOADING ONE TRACK OF TWO RAILS



Span in Feet	Maximum Moment in Foot-Kips	Maximum Shear in Kips	Maximum Floor-beam Reaction Kips	Equivalent Uniform Load		
				Moment	Shear	Reaction
7	21.9	12.5	15.1	3.57	3.57	2.15
7½	23.5	13.4	16.0	3.33	3.56	2.12
8	25.0	14.0	16.8	3.12	3.51	2.11
9	28.1	15.3	18.2	2.78	3.39	2.02
10	31.2	16.2	19.2	2.50	3.25	1.92
11	34.4	17.0	21.0	2.28	3.09	1.90
12	40.0	17.7	23.3	2.22	2.95	1.94
13	47.5	18.3	24.6	2.25	2.81	1.90
14	55.0	18.8	26.1	2.25	2.68	1.86
15	62.5	20.0	27.3	2.22	2.67	1.82
16	70.0	21.3	28.5	2.19	2.66	1.78
17	77.5	22.4	29.4	2.15	2.63	1.73
18	85.0	23.3	30.3	2.10	2.59	1.69
19	93.3	24.2	31.5	2.07	2.55	1.66
20	103.1	25.0	32.8	2.06	2.50	1.64
21	112.9	25.7	34.0	2.05	2.45	1.62
22	122.8	26.3	35.1	2.03	2.40	1.60
23	132.7	27.0	36.1	2.01	2.34	1.57
24	142.6	27.7	37.0	1.98	2.31	1.54
25	152.5	28.4	37.8	1.95	2.27	1.51
26	162.4	29.1	38.8	1.92	2.24	1.49
27	172.3	29.6	40.0	1.89	2.20	1.48
28	182.7	30.2	41.2	1.86	2.16	1.47
29	194.0	30.8	42.2	1.84	2.12	1.46
30	205.2	31.5	43.1	1.82	2.10	1.44
31	216.5	32.2	44.3	1.80	2.08	1.43
32	227.7	32.9	45.5	1.78	2.05	1.42
33	239.0	33.5	46.7	1.75	2.03	1.41
34	250.3	34.1	47.8	1.73	2.00	1.40
35	261.5	34.6	48.8	1.71	1.98	1.39
36	274.3	35.3	49.8	1.69	1.96	1.38
37	287.2	35.9	50.7	1.68	1.94	1.37
38	300.0	36.5	51.8	1.66	1.92	1.36
39	313.3	37.2	52.9	1.65	1.90	1.36
40	327.8	37.7	54.0	1.64	1.88	1.35

Span in Feet	Maximum Moment in Foot-Kips	Maximum Shear in Kips	Maximum Floor-beam Reaction Kips	Equivalent Uniform Load		
				Moment	Shear	Reaction
42	356.7	39.2	56.0	1.62	1.87	1.34
44	385.8	40.3	58.2	1.60	1.83	1.32
46	414.9	41.4	60.3	1.57	1.80	1.31
48	443.8	42.4	62.4	1.54	1.77	1.30
50	475.5	43.5	64.3	1.52	1.74	1.29
52	507.6	44.6	66.7	1.50	1.72	1.28
54	540.5	45.6	69.0	1.48	1.69	1.28
56	576.1	46.5	71.4	1.47	1.66	1.27
58	611.6	47.7	74.0	1.46	1.65	1.28
60	649.5	48.8	76.6	1.44	1.63	1.28
62	688.2	50.0	79.1	1.43	1.61	1.27
64	727.7	51.3	81.5	1.42	1.60	1.27
66	769.7	52.5	83.9	1.41	1.59	1.27
68	811.7	53.9	86.2	1.40	1.59	1.27
70	853.7	55.3	88.5	1.39	1.58	1.26
72	896.7	56.7	90.7	1.38	1.58	1.26
74	939.0	58.1	93.0	1.37	1.57	1.26
76	986.0	59.5	95.2	1.36	1.57	1.25
78	1032.7	60.9	97.3	1.36	1.56	1.25
80	1080.0	62.1	99.4	1.35	1.55	1.24
82	1128.3	63.5	101.5	1.34	1.55	1.24
84	1177.7	64.8	103.5	1.34	1.54	1.23
86	1229.7	66.1	105.4	1.33	1.54	1.23
88	1282.0	67.4	107.3	1.32	1.53	1.22
90	1334.7	68.6	109.3	1.32	1.53	1.22
92	1388.3	69.9	111.2	1.31	1.52	1.21
94	1442.7	71.2	113.1	1.31	1.52	1.20
96	1497.3	72.4	115.0	1.30	1.51	1.20
98	1552.7	73.7	116.8	1.29	1.51	1.19
100	1609.7	75.0	118.6	1.29	1.50	1.19
125	2497.7	89.7	140.5	1.28	1.44	1.12
150	3531.0	103.7	162.7	1.25	1.38	1.08
175	4676.3	117.3	185.8	1.22	1.34	1.06
200	5939.0	130.5	209.5	1.19	1.31	1.05
250	8796.3	156.6	257.6	1.13	1.25	1.03

DEFLECTION

$$D = \frac{0.01862\ L^2}{d}$$

Def. Coef. $= 0.01862L^2$

D = Deflection in Inches for Symmetrical Beams and Girders uniformly loaded to cause an 18000 # per sq. in. stress in extreme fibre of flange.

L = Span in feet.

d = Depth in Inches.

Span feet	deflection coeff.	d = depth in inches													
		3	4	5	6	7	8	9	10	12	15	18	20	21	22
3	.168	.056	.042	.033	.028	.024	.021	.019	.017	.014	.011	.009	.008	.008	.008
4	.298	.099	.074	.059	.050	.043	.037	.033	.030	.025	.020	.017	.015	.014	.014
5	.466	155	.116	.093	.078	.067	.058	.052	.047	.039	.031	.026	.023	.022	.021
6	.670	.223	.168	.134	.112	.096	.084	.074	.067	.056	.045	.037	.034	.032	.030
7	.912	.304	.228	.182	.152	.130	.114	.101	.091	.076	.061	.051	.046	.043	.041
8	1.19	.396	.298	.238	.198	.170	.149	.132	.119	.099	.079	.066	.060	.057	.054
9	1.51	.503	.378	.302	.252	.216	.189	.168	.151	.126	.101	.084	.076	.072	.069
10	1.86	620	.465	.372	.310	.266	.233	.207	.186	.155	.124	.103	.093	.089	.085
11	2.25	.750	.562	.450	.375	.321	.281	.250	.225	.188	.150	.125	.113	.107	.102
12	2.68	.896	.670	.537	.447	.383	.335	.298	.268	.223	.179	.149	.134	.123	.122
13	3.15	1 05	.787	.630	.525	.450	.394	.350	.315	.263	.210	.175	.158	.150	.143
14	3.65	1.22	.912	.730	.608	.521	.456	.406	.365	.304	.243	.203	.183	.174	166
15	4.19	1.39	1.05	.838	.698	.599	.524	.466	.419	.341	.279	.233	.210	200	.191
16	4.77	.....	1.19	.955	.795	.681	.596	.530	.477	.398	.318	.265	.239	.227	.217
17	5.39	.....	1.35	1.08	.898	.770	.674	.599	.539	.449	.359	.299	.270	.257	.241
18	6.03	.....	1.51	1.20	1.01	.861	.754	.670	.603	.503	.402	.335	.302	.287	.274
19	6.72	.....	1.68	1.34	1 12	.960	.840	.747	.672	.560	.448	.373	.336	.320	.305
20	7.45	.....	1.86	1.49	1.24	1.06	.931	.828	.745	.621	.497	.414	.373	.355	.339
21	8.21	.....	.....	1.64	1.37	1.17	1.03	.912	.821	.684	.547	.456	.411	.391	.373
22	9.01	.....	.....	1.80	1.51	1.29	1.13	1.00	.901	.751	.601	.501	.451	.429	.410
23	9.86	.....	.....	1.97	1.64	1.41	1.23	1.10	.986	.822	.651	.548	.493	.470	.448
24	10.73	.....	.....	2.14	1.79	1.53	1.34	1.19	1.07	.894	.715	.596	.537	.511	.488
25	11.64	.....	.....	2.33	1.94	1.66	1.46	1.29	1.16	.970	.776	.647	.582	.554	.529
26	12.59	.....	.....	.....	2.10	1.80	1.57	1.40	1.26	1.05	.839	.699	.630	.600	.572
27	13.57	.....	.....	.....	2.26	1.94	1.70	1.51	1.36	1.13	.905	.754	.679	.646	.617
28	14.60	.....	.....	.....	2.43	2.09	1.83	1.62	1.46	1.22	.973	.811	.736	.695	.664
29	15.66	.....	.....	.....	2.61	2.24	1.96	1.74	1.57	1 31	1.04	.870	.783	.746	.712
30	16.76	.....	.....	.....	2.79	2.39	2.10	1.86	1.68	1.40	1.12	.931	.838	.798	.762
31	17.89	.....	.....	.....	.....	2.56	2.24	1.99	1.79	1.49	1.19	.994	.895	.852	.813
32	19.07	.....	.....	.....	.....	2.72	2.38	2.12	1.91	1.59	1.27	1.06	.954	.908	.867
33	20.28	.....	.....	.....	.....	2.90	2.54	2.25	2.03	1.69	1.35	1.13	1.01	.966	.927
34	21.53	.....	.....	.....	.....	3.08	2.69	2.39	2.15	1.79	1.44	1.20	1.08	1.03	.979
35	22.81	.....	.....	.....	.....	3.26	2.85	2.53	2.28	1.90	1.52	1.27	1.14	1.09	1.04
36	24.13	.....	.....	.....	.....	.....	3.02	2.68	2.41	2.01	1.61	1.34	1.21	1.15	1.10
37	25.50	.....	.....	.....	.....	.....	3.19	2.83	2.55	2.13	1.70	1.42	1.28	1.21	1.16
38	26.89	.....	.....	.....	.....	.....	3.36	2.99	2.69	2.24	1.79	1.49	1.34	1.28	1.22
39	28.32	.....	.....	.....	.....	.....	3.54	3.15	2.83	2.36	1.89	1.57	1.42	1.35	1.29
40	29.79	.....	.....	.....	.....	.....	3.72	3.31	2.98	2.48	1.99	1.66	1.49	1.42	1.35
41	31.30	.....	.....	.....	.....	.....	.....	3.48	3.13	2.61	2.09	1.74	1.57	1.49	1.42
42	32.85	.....	.....	.....	.....	.....	.....	3.65	3.29	2.74	2.19	1.83	1.64	1.56	1.49
43	34.43	.....	.....	.....	.....	.....	.....	3 83	3.44	2.87	2.30	1.91	1.72	1.64	1.57
44	36.05	.....	.....	.....	.....	.....	.....	4.01	3.61	3.00	2.40	2.00	1.80	1.72	1.64
45	37.71	.....	.....	.....	.....	.....	.....	4.19	3.77	3.14	2.51	2.10	1.89	1.80	1.71
46	39.40	.....	.....	.....	.....	.....	.....	.....	3.94	3.28	2.63	2.19	1.97	1.88	1.79
47	41.13	.....	.....	.....	.....	.....	.....	.....	4.11	3.43	2.74	2.29	2.06	1.96	1.87
48	42.90	.....	.....	.....	.....	.....	.....	.....	4.29	3.58	2.86	2.38	2.15	2.04	1.95
49	44.71	.....	.....	.....	.....	.....	.....	.....	4.47	3.73	2.98	2.48	2.24	2.13	2.03
50	46.55	.....	.....	.....	.....	.....	.....	.....	4.66	3.88	3.10	2.59	2.33	2.21	2.12
51	48.43	.....	.....	.....	.....	.....	.....	.....	.....	4.04	3.24	2.69	2.42	2.31	2.20
52	50.35	.....	.....	.....	.....	.....	.....	.....	.....	4.20	3.36	2.80	2.52	2.40	2.29
53	52.31	.....	.....	.....	.....	.....	.....	.....	.....	4.36	3.49	2.91	2.62	2.49	2.33
54	54.30	.....	.....	.....	.....	.....	.....	.....	.....	4.53	3.62	3.02	2.72	2.59	2.47
55	56.33	.....	.....	.....	.....	.....	.....	.....	.....	4.69	3.76	3.13	2.82	2.68	2.56
56	58.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.89	3.24	2.92	2.78	2.65
58	64.82	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.18	3.48	3.13	2.98	2.85
60	67.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.47	3.72	3.35	3.19	3.05
65	78.67	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.24	4.37	3.93	3.75	3.58
70	91.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.08	5.07	4.56	4.34	4.15
75	104.74	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.98	5.82	5.24	4.99	4.76
80	119.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.62	5.96	5.68	5.42
85	134.53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.73	6.41	6.12
90	150.82	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.54	7.18	6.89
95	168.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.40	8.00	7.64
100	186.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.87	8.46

A Concentrated Center Load causing an 18000 # fibre stress is 50% of the uniformly distributed load. Deflection caused by a Concentrated Center Load is $0.01490\ L^2$ or 80% of that of a uniformly distributed load, shown in above tables. (See Note at foot of opposite page).

DEFLECTION

$D = \dfrac{0.01862\ L^2}{d}$

Def. Coef. $= 0.01862\ L^2$

D = Deflection in Inches for Symmetrical Beams and Girders uniformly loaded to cause an 18000 # per sq. in. stress in extreme fibre of flange.

L = Span in feet.

d = Depth in Inches.

Span feet	deflection coeff.	d = depth in inches													
		24	26	27	28	30	36	42	48	54	60	66	72	84	96
3	0.168	.006	.006												
4	0.298	.012	.011												
5	0.466	.019	.018												
6	0.670	.028	.026	.025	.024	.022									
7	0.912	.038	.035	.034	.033	.030									
8	1.19	.050	.046	.044	.043	.040									
9	1.51	.063	.058	.056	.054	.050									
10	1.86	.078	.072	.069	.066	.062	.052	.044	.039						
11	2.25	.094	.087	.083	.080	.075	.062	.054	.047						
12	2.68	.112	.103	.099	.096	.089	.074	.064	.056						
13	3.15	.131	.121	.117	.113	.105	.088	.075	.066						
14	3.65	.152	.140	.135	.123	.122	.102	.087	.076						
15	4.19	.175	.161	.155	.150	.140	.116	.100	.087	.078	.070				
16	4.77	.199	.183	.177	.170	.159	.133	.114	.099	.088	.080				
17	5.39	.225	.207	.200	.193	.180	.150	.128	.112	.100	.090				
18	6.03	.251	.232	.223	.215	.201	.168	.144	.126	.112	.101				
19	6.72	.280	.258	.249	.240	.224	.187	.160	.140	.124	.112				
20	7.45	.310	.287	.276	.266	.248	.207	.177	.155	.138	.124	.113	.103	.088	.078
21	8.21	.342	.316	.304	.293	.274	.228	.195	.171	.152	.137	.124	.114	.098	.086
22	9.01	.375	.347	.334	.322	.300	.250	.215	.188	.167	.150	.137	.125	.107	.094
23	9.86	.411	.379	.365	.352	.329	.274	.235	.205	.183	.164	.149	.137	.117	.103
24	10.73	.447	.413	.397	.383	.358	.298	.255	.224	.199	.179	.163	.149	.128	.112
25	11.64	.485	.448	.431	.416	.388	.323	.277	.243	.216	.194	.176	.162	.139	.121
26	12.59	.525	.484	.466	.450	.420	.350	.300	.262	.233	.210	.191	.175	.150	.131
27	13.57	.566	.522	.503	.485	.452	.377	.323	.283	.251	.226	.206	.188	.162	.141
28	14.60	.608	.562	.540	.521	.487	.406	.348	.304	.270	.243	.221	.203	.174	.152
29	15.66	.653	.602	.580	.559	.522	.435	.373	.326	.290	.261	.237	.218	.186	.163
30	16.76	.698	.645	.621	.599	.559	.466	.399	.349	.310	.279	.254	.233	.200	.164
31	17.89	.746	.688	.662	.639	.596	.497	.426	.373	.331	.298	.271	.249	.213	.186
32	19.07	.795	.733	.706	.681	.636	.530	.454	.398	.353	.318	.289	.265	.227	.199
33	20.28	.845	.780	.751	.724	.676	.563	.483	.423	.376	.338	.307	.282	.241	.211
34	21.53	.897	.832	.797	.769	.718	.598	.513	.449	.399	.359	.326	.299	.256	.224
35	22.81	.950	.877	.844	.815	.760	.634	.543	.475	.422	.380	.346	.317	.272	.238
36	24.13	1.01	.928	.894	.862	.804	.670	.575	.503	.447	.402	.366	.335	.287	.251
37	25.50	1.06	.981	.944	.911	.850	.708	.607	.531	.472	.425	.386	.354	.304	.266
38	26.89	1.12	1.03	.996	.960	.896	.747	.640	.560	.498	.448	.407	.373	.320	.280
39	28.32	1.18	1.09	1.05	1.01	.944	.787	.674	.590	.525	.472	.429	.393	.337	.295
40	29.79	1.24	1.15	1.10	1.06	.993	.828	.709	.621	.552	.497	.451	.414	.355	.310
41	31.30	1.30	1.20	1.16	1.12	1.04	.869	.745	.652	.579	.522	.474	.435	.373	.326
42	32.85	1.37	1.26	1.22	1.17	1.10	.913	.782	.684	.608	.548	.498	.456	.390	.342
43	34.43	1.43	1.32	1.28	1.23	1.15	.956	.820	.717	.638	.574	.522	.478	.410	.358
44	36.05	1.50	1.39	1.34	1.29	1.20	1.00	.858	.751	.668	.601	.546	.501	.429	.376
45	37.71	1.57	1.45	1.40	1.35	1.26	1.05	.898	.786	.698	.629	.571	.524	.449	.393
46	39.40	1.64	1.52	1.46	1.40	1.31	1.09	.938	.821	.730	.657	.597	.547	.469	.410
47	41.13	1.71	1.58	1.52	1.47	1.37	1.14	.979	.857	.762	.686	.623	.571	.490	.428
48	42.90	1.79	1.65	1.59	1.53	1.43	1.19	1.02	.894	.794	.745	.650	.596	.511	.447
49	44.71	1.86	1.72	1.66	1.60	1.49	1.24	1.06	.931	.829	.745	.677	.621	.532	.466
50	46.55	1.94	1.79	1.72	1.66	1.55	1.29	1.11	.970	.862	.776	.705	.647	.554	.485
51	48.43	2.02	1.87	1.79	1.73	1.61	1.35	1.15	1.01	.897	.807	.734	.673	.577	.504
52	50.35	2.10	1.94	1.86	1.80	1.68	1.40	1.20	1.05	.932	.839	.763	.699	.599	.524
53	52.51	2.18	2.01	1.94	1.87	1.74	1.45	1.25	1.09	.969	.872	.793	.727	.623	.545
54	54.30	2.26	2.09	2.01	1.94	1.81	1.51	1.29	1.11	1.01	.905	.823	.754	.646	.566
55	56.33	2.35	2.17	2.09	2.01	1.88	1.56	1.34	1.17	1.04	.939	.853	.782	.671	.587
56	58.40	2.43	2.25	2.16	2.09	1.95	1.62	1.39	1.22	1.08	.973	.885	.811	.695	.504
58	62.64	2.61	2.41	2.32	2.24	2.09	1.74	1.49	1.31	1.16	1.04	.949	.870	.746	.653
60	67.03	2.79	2.58	2.48	2.39	2.23	1.86	1.60	1.40	1.24	1.12	1.02	.931	.798	.698
65	78.67	3.28	3.03	2.91	2.81	2.62	2.19	1.87	1.64	1.46	1.31	1.19	1.09	.937	.819
70	91.24	3.80	3.51	3.38	3.26	3.04	2.52	2.17	1.90	1.69	1.52	1.38	1.27	1.09	.950
75	104.74	4.36	4.03	3.88	3.74	3.49	2.91	2.49	2.18	1.94	1.75	1.59	1.45	1.25	1.09
80	119.17	4.97	4.58	4.41	4.26	3.97	3.31	2.84	2.48	2.21	1.99	1.81	1.66	1.42	1.24
85	134.53	5.61	5.17	4.98	4.80	4.48	3.74	3.20	2.81	2.49	2.24	2.04	1.87	1.60	1.40
90	150.82	6.28	5.81	5.59	5.39	5.03	4.19	3.59	3.14	2.79	2.51	2.29	2.10	1.80	1.57
95	168.05	7.00	6.46	6.22	6.00	5.60	4.67	4.00	3.50	3.11	2.80	2.55	2.33	2.00	1.75
100	186.20	7.76	7.16	6.90	6.65	6.21	5.17	4.43	3.88	3.45	3.10	2.82	2.59	2.22	1.94

For fibre stresses other than 18000 # per sq. in., on which the above table is based, the deflection is directly proportional to the flange stress developed. Thus a fibre stress of 12000 # per sq. in. gives a deflection equal to ⅔ of that shown in above table.

.01 TO .49 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
.01	.0001	.000001	0.1000	0.2154	$\bar{2}$.00000	100000.000	.03142	.000079
.02	.0004	.000008	0.1414	0.2714	$\bar{2}$.30103	50000.000	.06283	.000314
.03	.0009	.000027	0.1732	0.3107	$\bar{2}$.47712	33333.333	.09425	.000707
.04	.0016	.000064	0.2000	0.3420	$\bar{2}$.60206	25000.000	.12566	.001257
.05	.0025	.000125	0.2236	0.3684	$\bar{2}$.69897	20000.000	.15708	.001964
.06	.0036	.000216	0.2449	0.3915	$\bar{2}$.77815	16666.667	.18850	.002827
.07	.0049	.000343	0.2646	0.4121	$\bar{2}$.84510	14285.714	.21991	.003849
.08	.0064	.000512	0.2828	0.4309	$\bar{2}$.90309	12500.000	.25133	.005027
.09	.0081	.000729	0.3000	0.4481	$\bar{2}$.95424	11111.111	.28274	.006362
.10	.0100	.001000	0.3162	0.4642	$\bar{1}$.00000	10000.000	.31416	.007854
.11	.0121	.001331	0.3317	0.4791	$\bar{1}$.04139	9090.909	.34558	.009503
.12	.0144	.001728	0.3464	0.4932	$\bar{1}$.07918	8333.333	.37699	.011310
.13	.0169	.002197	0.3606	0.5066	$\bar{1}$.11394	7692.308	.40841	.013273
.14	.0196	.002744	0.3742	0.5192	$\bar{1}$.14613	7142.857	.43982	.015394
.15	.0225	.003375	0.3873	0.5313	$\bar{1}$.17609	6666.667	.47124	.017672
.16	.0256	.004096	0.4000	0.5429	$\bar{1}$.20412	6250.000	.50265	.020106
.17	.0289	.004913	0.4123	0.5540	$\bar{1}$.23045	5882.353	.53407	.022698
.18	.0324	.005832	0.4243	0.5646	$\bar{1}$.25527	5555.556	.56549	.025447
.19	.0361	.006859	0.4359	0.5749	$\bar{1}$.27875	5263.158	.59690	.028353
.20	.0400	.008000	0.4472	0.5848	$\bar{1}$.30103	5000.000	.62832	.031416
.21	.0441	.009261	0.4583	0.5944	$\bar{1}$.32222	4761.905	.65973	.034636
.22	.0484	.010648	0.4690	0.6037	$\bar{1}$.34242	4545.455	.69115	.038013
.23	.0529	.012167	0.4796	0.6127	$\bar{1}$.36173	4347.826	.72257	.041548
.24	.0576	.013824	0.4899	0.6214	$\bar{1}$.38021	4166.667	.75398	.045239
.25	.0625	.015625	0.5000	0.6300	$\bar{1}$.39794	4000.000	.78540	.049087
.26	.0676	.017576	0.5099	0.6383	$\bar{1}$.41497	3846.154	.81681	.053093
.27	.0729	.019683	0.5196	0.6463	$\bar{1}$.43136	3703.704	.84823	.057256
.28	.0784	.021952	0.5292	0.6542	$\bar{1}$.44716	3571.429	.87965	.061575
.29	.0841	.024389	0.5385	0.6619	$\bar{1}$.46240	3448.276	.91106	.066052
.30	.0900	.027000	0.5477	0.6694	$\bar{1}$.47712	3333.333	.94248	.070686
.31	.0961	.029791	0.5568	0.6768	$\bar{1}$.49136	3225.807	.97389	.075477
.32	.1024	.032768	0.5657	0.6840	$\bar{1}$.50515	3125.000	1 00531	.080425
.33	.1089	.035937	0.5745	0.6910	$\bar{1}$.51851	3030.303	1.03673	.085530
.34	.1156	.039304	0.5831	0.6980	$\bar{1}$.53148	2941.177	1.06814	.090792
.35	.1225	.042875	0.5916	0.7047	$\bar{1}$ 54407	2857.143	1.09956	.096211
.36	.1296	.046656	0.6000	0.7114	$\bar{1}$.55630	2777.778	1.13097	.101788
.37	.1369	.050653	0.6083	0.7179	$\bar{1}$.56820	2702.703	1.16239	.107521
.38	.1444	.054872	0.6164	0.7243	$\bar{1}$.57978	2631.579	1.19381	.113411
.39	.1521	.059319	0.6245	0 7306	$\bar{1}$.59106	2564.103	1.22522	.119459
.40	.1600	.064000	0.6325	0 7368	$\bar{1}$.60206	2500.000	1.2566	.125664
.41	.1681	.068921	0.6403	0.7429	$\bar{1}$.61278	2439.024	1.2881	.132025
.42	.1764	.074088	0.6481	0.7489	$\bar{1}$.62325	2380.952	1.3195	.138544
.43	.1849	.079507	0.6557	0.7548	$\bar{1}$.63347	2325.581	1.3509	.145220
.44	.1936	.085184	0.6633	0.7606	$\bar{1}$.64345	2272.727	1.3823	.152053
.45	.2025	.091125	0.6708	0.7663	$\bar{1}$.65321	2222.222	1.4137	.159043
.46	.2116	.097336	0.6782	0.7719	$\bar{1}$.66276	2173.913	1.4451	.166190
.47	.2209	.103823	0.6856	0.7775	$\bar{1}$.67210	2127.660	1.4765	.173494
.48	.2304	.110592	0.6928	0.7830	$\bar{1}$.68124	2083.333	1.5080	.180956
.49	.2401	.117649	0.7000	0.7884	$\bar{1}$.69020	2040.816	1.5394	.188574

FUNCTIONS OF NUMBERS .50 TO .99

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
.50	.2500	.125000	0.7071	0.7937	$\bar{1}.69897$	2000.000	1.5708	.19635
.51	.2601	.132651	0.7141	0.7990	$\bar{1}.70757$	1960.784	1.6022	.20428
.52	.2704	.140608	0 7211	0.8041	$\bar{1}.71600$	1923.077	1.6336	.21237
.53	.2809	.148877	0.7280	0.8093	$\bar{1}.72428$	1886.793	1.6650	.22062
.54	.2916	.157464	0.7348	0.8143	$\bar{1}.73239$	1851.852	1.6965	.22902
.55	.3025	.166375	0.7416	0.8193	$\bar{1}.74036$	1818.182	1.7279	.23758
.56	.3136	.175616	0.7483	0.8243	$\bar{1}.74819$	1785.714	1.7593	.24630
.57	.3249	.185193	0.7550	0.8291	$\bar{1}.75587$	1754.386	1.7907	.25518
.58	.3364	.195112	0.7616	0.8340	$\bar{1}.76343$	1724.138	1.8221	.26401
.59	.3481	.205379	0.7681	0.8387	$\bar{1}.77085$	1694.915	1.8535	.27340
.60	.3600	.216000	0.7746	0.8434	$\bar{1}.77815$	1666.667	1.8850	.28274
.61	.3721	.226981	0.7810	0.8481	$\bar{1}.78533$	1639.344	1.9164	.29225
.62	.3844	.238328	0.7874	0.8527	$\bar{1}.79239$	1612.903	1.9478	.30191
.63	.3969	.250047	0.7937	0.8573	$\bar{1}.79934$	1587.302	1.9792	.31173
.64	.4096	.262144	0.8000	0.8618	$\bar{1}.80618$	1562.500	2.0106	.32170
.65	.4225	.274625	0.8062	0.8662	$\bar{1}.81291$	1538.462	2.0420	.33183
.66	.4356	.287496	0.8124	0.8707	$\bar{1}.81954$	1515.152	2.0735	.34212
.67	.4489	.300763	0.8185	0.8750	$\bar{1}.82607$	1492.537	2.1049	.35257
.68	.4624	.314432	0.8246	0.8794	$\bar{1}.83251$	1470.588	2.1363	.36317
.69	.4761	.328509	0.8307	0.8837	$\bar{1}.83885$	1449.275	2.1677	.37393
.70	.4900	.343000	0.8367	0.8879	$\bar{1}.84510$	1428.571	2.1991	.38485
.71	.5041	.357911	0.8426	0.8921	$\bar{1}.85126$	1408.451	2.2305	.39592
.72	.5184	.373248	0.8485	0.8963	$\bar{1}.85733$	1388.889	2.2620	.40715
.73	.5329	.389017	0.8544	0.9004	$\bar{1}.86332$	1369.863	2.2934	.41854
.74	.5476	.405224	0.8602	0.9045	$\bar{1}.86923$	1351.351	2.3248	.43008
.75	.5625	.421875	0.8660	0.9086	$\bar{1}.87506$	1333.333	2.3562	.44179
.76	.5776	.438976	0.8718	0.9126	$\bar{1}.88081$	1315.790	2.3876	.45365
.77	.5929	.456533	0.8775	0.9166	$\bar{1}.88649$	1298 701	2.4190	.46566
.78	.6084	.474552	0.8832	0.9205	$\bar{1}.89209$	1282.051	2.4504	.47784
.79	.6241	.493039	0.8888	0.9244	$\bar{1}.89763$	1265.823	2.4819	.49017
.80	.6400	512000	0.8944	0.9283	$\bar{1}.90309$	1250.000	2.5133	.50266
.81	.6561	.531441	0.9000	0.9322	$\bar{1}.90849$	1234.568	2.5447	.51530
.82	.6724	.551368	0.9055	0.9360	$\bar{1}.91381$	1219.512	2.5761	.52810
.83	.6889	.571787	0.9110	0.9398	$\bar{1}.91908$	1204.819	2.6075	.54106
.84	.7056	.592704	0.9165	0.9435	$\bar{1}.92428$	1190.476	2.6389	.55418
.85	.7225	.614125	0.9220	0.9473	$\bar{1}.92942$	1176.471	2.6704	.56745
.86	.7396	.636056	0.9274	0.9510	$\bar{1}.93450$	1162.791	2.7018	.58088
.87	.7569	.658503	0.9327	0.9546	$\bar{1}.93952$	1149.425	2.7332	.59447
88	.7744	.681472	0.9381	0 9583	$\bar{1}.94448$	1136.364	2.7646	.60821
.89	.7921	.704969	0.9434	0 9619	$\bar{1}.94939$	1123.596	2.7960	.62211
.90	.8100	.729000	0.9487	0.9655	$\bar{1}.95424$	1111.111	2.8274	.63617
.91	.8281	.753571	0.9539	0.9691	$\bar{1}.95904$	1098 901	2.8589	.65039
.92	.8464	.778688	0.9592	0.9726	$\bar{1}.96379$	1086.957	2.8903	.66476
.93	.8649	.804357	0.9644	0.9761	$\bar{1}.96848$	1075.269	2.9217	.67929
.94	.8836	.830584	0.9695	0 9796	$\bar{1}.97313$	1063.830	2.9531	.69398
.95	.9025	.857375	0.9747	0.9830	$\bar{1}.97772$	1052.632	2.9845	.70882
96	.9216	.884736	0.9798	0.9865	$\bar{1}.98227$	1041.667	3.0159	.72382
.97	.9409	.912673	0.9849	0.9899	$\bar{1}.98677$	1030.928	3.0473	.73898
.98	.9604	.941192	0.9899	0 9933	$\bar{1}.99123$	1020.408	3.0788	.75430
.99	.9801	.970299	0 9950	0 9967	$\bar{1}$ 99564	1010.101	3.1102	.76977

1 TO 49 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
1	1	1	1.0000	1.0000	0.00000	1000.000	3.142	0.7854
2	4	8	1.4142	1.2599	0.30103	500.000	6.283	3.1416
3	9	27	1.7321	1.4422	0.47712	333.333	9.425	7.0686
4	16	64	2.0000	1.5874	0.60206	250.000	12.566	12.5664
5	25	125	2.2361	1.7100	0.69897	200.000	15.708	19.6350
6	36	216	2.4495	1.8171	0.77815	166.667	18.850	28.2743
7	49	343	2.6458	1.9129	0.84510	142.857	21.991	38.4845
8	64	512	2.8284	2.0000	0.90309	125.000	25.133	50.2655
9	81	729	3.0000	2.0801	0.95424	111.111	28.274	63.6173
10	100	1000	3.1623	2.1544	1.00000	100.000	31.416	78.5398
11	121	1331	3.3166	2.2240	1.04139	90.9091	34.558	95.0332
12	144	1728	3.4641	2.2894	1.07918	83.3333	37.699	113.097
13	169	2197	3.6056	2.3513	1.11394	76.9231	40.841	132.732
14	196	2744	3.7417	2.4101	1.14613	71.4286	43.982	153.938
15	225	3375	3.8730	2.4662	1.17609	66.6667	47.124	176.715
16	256	4096	4.0000	2.5198	1.20412	62.5000	50.265	201.062
17	289	4913	4.1231	2.5713	1.23045	58.8235	53.407	226.980
18	324	5832	4.2426	2.6207	1.25527	55.5556	56.549	254.469
19	361	6859	4.3589	2.6684	1.27875	52.6316	59.690	283.529
20	400	8000	4.4721	2.7144	1.30103	50.0000	62.832	314.159
21	441	9261	4.5826	2.7589	1.32222	47.6190	65.973	346.361
22	484	10648	4.6904	2.8020	1.34242	45.4545	69.115	380.133
23	529	12167	4.7958	2.8439	1.36173	43.4783	72.257	415.476
24	576	13824	4.8990	2.8845	1.38021	41.6667	75.398	452.389
25	625	15625	5.0000	2.9240	1.39794	40.0000	78.540	490.874
26	676	17576	5.0990	2.9625	1.41497	38.4615	81.681	530.929
27	729	19683	5.1962	3.0000	1.43136	37.0370	84.823	572.555
28	784	21952	5.2915	3.0366	1.44716	35.7143	87.965	615.752
29	841	24389	5.3852	3.0723	1.46240	34.4828	91.106	660.520
30	900	27000	5.4772	3.1072	1.47712	33.3333	94.248	706.858
31	961	29791	5.5678	3.1414	1.49136	32.2581	97.389	754.768
32	1024	32768	5.6569	3.1748	1.50515	31.2500	100.531	804.248
33	1089	35937	5.7446	3.2075	1.51851	30.3030	103.673	855.299
34	1156	39304	5.8310	3.2396	1.53148	29.4118	106.814	907.920
35	1225	42875	5.9161	3.2711	1.54407	28.5714	109.956	962.113
36	1296	46656	6.0000	3.3019	1.55630	27.7778	113.097	1017.88
37	1369	50653	6.0828	3.3322	1.56820	27.0270	116.239	1075.21
38	1444	54872	6.1644	3.3620	1.57978	26.3158	119.381	1134.11
39	1521	59319	6.2450	3.3912	1.59106	25.6410	122.522	1194.59
40	1600	64000	6.3246	3.4200	1.60206	25.0000	125.66	1256.64
41	1681	68921	6.4031	3.4482	1.61278	24.3902	128.81	1320.25
42	1764	74088	6.4807	3.4760	1.62325	23.8095	131.95	1385.44
43	1849	79507	6.5574	3.5034	1.63347	23.2558	135.09	1452.20
44	1936	85184	6.6332	3.5303	1.64345	22.7273	138.23	1520.53
45	2025	91125	6.7082	3.5569	1.65321	22.2222	141.37	1590.43
46	2116	97336	6.7823	3.5830	1.66276	21.7391	144.51	1661.90
47	2209	103823	6.8557	3.6088	1.67210	21.2766	147.65	1734.94
48	2304	110592	6.9282	3.6342	1.68124	20.8333	150.80	1809.56
49	2401	117649	7.0000	3.6593	1.69020	20.4082	153.94	1885.74

FUNCTIONS OF NUMBERS 50 TO 99

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
50	2500	125000	7.0711	3.6840	1.69897	20.0000	157.08	1963.50
51	2601	132651	7.1414	3.7084	1.70757	19.6078	160.22	2042.82
52	2704	140608	7.2111	3.7325	1.71600	19.2308	163.36	2123.72
53	2809	148877	7.2801	3.7563	1.72428	18.8679	166.50	2206.18
54	2916	157464	7.3485	3.7798	1.73239	18.5185	169.65	2290.22
55	3025	166375	7.4162	3.8030	1.74036	18.1818	172.79	2375.83
56	3136	175616	7.4833	3.8259	1.74819	17.8571	175.93	2463.01
57	3249	185193	7.5498	3.8485	1.75587	17.5439	179.07	2551.76
58	3364	195112	7.6158	3.8709	1.76343	17.2414	182.21	2642.08
59	3481	205379	7.6811	3.8930	1.77085	16.9492	185.35	2733.97
60	3600	216000	7.7460	3.9149	1.77815	16.6667	188.50	2827.43
61	3721	226981	7.8102	3.9365	1.78533	16.3934	191.64	2922.47
62	3844	238328	7.8740	3.9579	1.79239	16.1290	194.78	3019.07
63	3969	250047	7.9373	3.9791	1.79934	15.8730	197.92	3117.25
64	4096	262144	8.0000	4.0000	1.80618	15.6250	201.06	3216.99
65	4225	274625	8.0623	4.0207	1.81291	15.3846	204.20	3318.31
66	4356	287496	8.1240	4.0412	1.81954	15.1515	207.35	3421.19
67	4489	300763	8.1854	4.0615	1.82607	14.9254	210.49	3525.65
68	4624	314432	8.2462	4.0817	1.83251	14.7059	213.63	3631.68
69	4761	328509	8.3066	4.1016	1.83885	14.4928	216.77	3739.28
70	4900	343000	8.3666	4.1213	1.84510	14.2857	219.91	3848.45
71	5041	357911	8.4261	4.1408	1.85126	14.0845	223.05	3959.19
72	5184	373248	8.4853	4.1602	1.85733	13.8889	226.19	4071.50
73	5329	389017	8.5440	4.1793	1.86332	13.6986	229.34	4185.39
74	5476	405224	8.6023	4.1983	1.86923	13.5135	232.48	4300.84
75	5625	421875	8.6603	4.2172	1.87506	13.3333	235.62	4417.86
76	5776	438976	8.7178	4.2358	1.88081	13.1579	238.76	4536.46
77	5929	456533	8.7750	4.2543	1.88649	12.9870	241.90	4656.63
78	6084	474552	8.8318	4.2727	1.89209	12.8205	245.04	4778.36
79	6241	493039	8.8882	4.2908	1.89763	12.6582	248.19	4901.67
80	6400	512000	8.9443	4.3089	1.90309	12.5000	251.33	5026.55
81	6561	531441	9.0000	4.3267	1.90849	12.3457	254.47	5153.00
82	6724	551368	9.0554	4.3445	1.91381	12.1951	257.61	5281.02
83	6889	571787	9.1104	4.3621	1.91908	12.0482	260.75	5410.61
84	7056	592704	9.1652	4.3795	1.92428	11.9048	263.89	5541.77
85	7225	614125	9.2195	4.3968	1.92942	11.7647	267.04	5674.50
86	7396	636056	9.2736	4.4140	1.93450	11.6279	270.18	5808.80
87	7569	658503	9.3274	4.4310	1.93952	11.4943	273.32	5944.68
88	7744	681472	9.3808	4.4480	1.94448	11.3636	276.46	6082.12
89	7921	704969	9.4340	4.4647	1.94939	11.2360	279.60	6221.14
90	8100	729000	9.4868	4.4814	1.95424	11.1111	282.74	6361.73
91	8281	753571	9.5394	4.4979	1.95904	10.9890	285.88	6503.88
92	8464	778688	9.5917	4.5144	1.96379	10.8696	289.03	6647.61
93	8649	804357	9.6437	4.5307	1.96848	10.7527	292.17	6792.91
94	8836	830584	9.6954	4.5468	1.97313	10.6383	295.31	6939.78
95	9025	857375	9.7468	4.5629	1.97772	10.5263	298.45	7088.22
96	9216	884736	9.7980	4.5789	1.98227	10.4167	301.59	7238.23
97	9409	912673	9.8489	4.5947	1.98677	10.3093	304.73	7389.81
98	9604	941192	9.8995	4.6104	1.99123	10.2041	307.88	7542.96
99	9801	970299	9.9499	4.6261	1.99564	10.1010	311.02	7697.69

100 TO 149 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
100	10000	1000000	10.0000	4.6416	2.00000	10.0000	314.16	7853.98
101	10201	1030301	10.0499	4.6570	2.00432	9.90099	317.30	8011.85
102	10404	1061208	10.0995	4.6723	2.00860	9.80392	320.44	8171.28
103	10609	1092727	10.1489	4.6875	2.01284	9.70874	323.58	8332.29
104	10816	1124864	10.1980	4.7027	2.01703	9.61538	326.73	8494.87
105	11025	1157625	10.2470	4.7177	2.02119	9.52381	329.87	8659.01
106	11236	1191016	10.2956	4.7326	2.02531	9.43396	333.01	8824.73
107	11449	1225043	10.3441	4.7475	2.02938	9.34579	336.15	8992.02
108	11664	1259712	10.3923	4.7622	2.03342	9.25926	339.29	9160.88
109	11881	1295029	10.4403	4.7769	2.03743	9.17431	342.43	9331.32
110	12100	1331000	10.4881	4.7914	2.04139	9.09091	345.58	9503.32
111	12321	1367631	10.5357	4.8059	2.04532	9.00901	348.72	9676.89
112	12544	1404928	10.5830	4.8203	2.04922	8.92857	351.86	9852.03
113	12769	1442897	10.6301	4.8346	2.05308	8.84956	355.00	10028.7
114	12996	1481544	10.6771	4.8488	2.05690	8.77193	358.14	10207.0
115	13225	1520875	10.7238	4.8629	2.06070	8.69565	361.28	10386.9
116	13456	1560896	10.7703	4.8770	2.06446	8.62069	364.42	10568.3
117	13689	1601613	10.8167	4.8910	2.06819	8.54701	367.57	10751.3
118	13924	1643032	10.8628	4.9049	2.07188	8.47458	370.71	10935.9
119	14161	1685159	10.9087	4.9187	2.07555	8.40336	373.85	11122.0
120	14400	1728000	10.9545	4.9324	2.07918	8.33333	376.99	11309.7
121	14641	1771561	11.0000	4.9461	2.08279	8.26446	380.13	11499.0
122	14884	1815848	11.0454	4.9597	2.08636	8.19672	383.27	11689.9
123	15129	1860867	11.0905	4.9732	2.08991	8.13008	386.42	11882.3
124	15376	1906624	11.1355	4.9866	2.09342	8.06452	389.56	12076.3
125	15625	1953125	11.1803	5.0000	2.09691	8.00000	392.70	12271.8
126	15876	2000376	11.2250	5.0133	2.10037	7.93651	395.84	12469.0
127	16129	2048383	11.2694	5.0265	2.10380	7.87402	398.98	12667.7
128	16384	2097152	11.3137	5.0397	2.10721	7.81250	402.12	12868.0
129	16641	2146689	11.3578	5.0528	2.11059	7.75194	405.27	13069.8
130	16900	2197000	11.4018	5.0658	2.11394	7.69231	408.41	13273.2
131	17161	2248091	11.4455	5.0788	2.11727	7.63359	411.55	13478.2
132	17424	2299968	11.4891	5.0916	2.12057	7.57576	414.69	13684.8
133	17689	2352637	11.5326	5.1045	2.12385	7.51880	417.83	13892.9
134	17956	2406104	11.5758	5.1172	2.12710	7.46269	420.97	14102.6
135	18225	2460375	11.6190	5.1299	2.13033	7.40741	424.12	14313.9
136	18496	2515456	11.6619	5.1426	2.13354	7.35294	427.26	14526.7
137	18769	2571353	11.7047	5.1551	2.13672	7.29927	430.40	14741.1
138	19044	2628072	11.7473	5.1676	2.13988	7.24638	433.54	14957.1
139	19321	2685619	11.7898	5.1801	2.14301	7.19424	436.68	15174.7
140	19600	2744000	11.8322	5.1925	2.14613	7.14286	439.82	15393.8
141	19881	2803221	11.8743	5.2048	2.14922	7.09220	442.96	15614.5
142	20164	2863288	11.9164	5.2171	2.15229	7.04225	446.11	15836.8
143	20449	2924207	11.9583	5.2293	2.15534	6.99301	449.25	16060.6
144	20736	2985984	12.0000	5.2415	2.15836	6.94444	452.39	16286.0
145	21025	3048625	12.0416	5.2536	2.16137	6.89655	455.53	16513.0
146	21316	3112136	12.0830	5.2656	2.16435	6.84932	458.67	16741.5
147	21609	3176523	12.1244	5.2776	2.16732	6.80272	461.81	16971.7
148	21904	3241792	12.1655	5.2896	2.17026	6.75676	464.96	17203.4
149	22201	3307949	12.2066	5.3015	2.17319	6.71141	468.10	17436.6

FUNCTIONS OF NUMBERS 150 TO 199

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
150	22500	3375000	12.2474	5.3133	2.17609	6.66667	471.24	17671.5
151	22801	3442951	12.2882	5.3251	2.17898	6.62252	474.38	17907.9
152	23104	3511808	12.3288	5.3368	2.18184	6.57895	477.52	18145.8
153	23409	3581577	12.3693	5.3485	2.18469	6.53595	480.66	18385.4
154	23716	3652264	12.4097	5.3601	2.18752	6.49351	483.81	18626.5
155	24025	3723875	12.4499	5.3717	2.19033	6.45161	486.95	18869.2
156	24336	3796416	12.4900	5.3832	2.19312	6.41026	490.09	19113.4
157	24649	3869893	12.5300	5.3947	2.19590	6.36943	493.23	19359.3
158	24964	3944312	12.5698	5.4061	2.19866	6.32911	496.37	19606.7
159	25281	4019679	12.6095	5.4175	2.20140	6.28931	499.51	19855.7
160	25600	4096000	12.6491	5.4288	2.20412	6.25000	502.65	20106.2
161	25921	4173281	12.6886	5.4401	2.20683	6.21118	505.80	20358.3
162	26244	4251528	12.7279	5.4514	2.20952	6.17284	508.94	20612.0
163	26569	4330747	12.7671	5.4626	2.21219	6.13497	512.08	20867.2
164	26896	4410944	12.8062	5.4737	2.21484	6.09756	515.22	21124.1
165	27225	4492125	12.8452	5.4848	2.21748	6.06061	518.36	21382.5
166	27556	4574296	12.8841	5.4959	2.22011	6.02410	521.50	21642.4
167	27889	4657463	12.9228	5.5069	2.22272	5.98802	524.65	21904.0
168	28224	4741632	12.9615	5.5178	2.22531	5.95238	527.79	22167.1
169	28561	4826809	13.0000	5.5288	2.22789	5.91716	530.93	22431.8
170	28900	4913000	13.0384	5.5397	2.23045	5.88235	534.07	22698.0
171	29241	5000211	13.0767	5.5505	2.23300	5.84795	537.21	22965.8
172	29584	5088448	13.1149	5.5613	2.23553	5.81395	540.35	23235.2
173	29929	5177717	13.1529	5.5721	2.23805	5.78035	543.50	23506.2
174	30276	5268024	13.1909	5.5828	2.24055	5.74713	546.64	23778.7
175	30625	5359375	13.2288	5.5934	2.24304	5.71429	549.78	24052.8
176	30976	5451776	13.2665	5.6041	2.24551	5.68182	552.92	24328.5
177	31329	5545233	13.3041	5.6147	2.24797	5.64972	556.06	24605.7
178	31684	5639752	13.3417	5.6252	2.25042	5.61798	559.20	24884.6
179	32041	5735339	13.3791	5.6357	2.25285	5.58659	562.35	25164.9
180	32400	5832000	13.4164	5.6462	2.25527	5.55556	565.49	25446.9
181	32761	5929741	13.4536	5.6567	2.25768	5.52486	568.63	25730.4
182	33124	6028568	13.4907	5.6671	2.26007	5.49451	571.77	26015.5
183	33489	6128487	13.5277	5.6774	2.26245	5.46448	574.91	26302.2
184	33856	6229504	13.5647	5.6877	2.26482	5.43478	578.05	26590.4
185	34225	6331625	13.6015	5.6980	2.26717	5.40541	581.19	26880.3
186	34596	6434856	13.6382	5.7083	2.26951	5.37634	584.34	27171.6
187	34969	6539203	13.6748	5.7185	2.27184	5.34759	587.48	27464.6
188	35344	6644672	13.7113	5.7287	2.27416	5.31915	590.62	27759.1
189	35721	6751269	13.7477	5.7388	2.27646	5.29101	593.76	28055.2
190	36100	6859000	13.7840	5.7489	2.27875	5.26316	596.90	28352.9
191	36481	6967871	13.8203	5.7590	2.28103	5.23560	600.04	28652.1
192	36864	7077888	13.8564	5.7690	2.28330	5.20833	603.19	28952.9
193	37249	7189057	13.8924	5.7790	2.28556	5.18135	606.33	29255.3
194	37636	7301384	13.9284	5.7890	2.28780	5.15464	609.47	29559.2
195	38025	7414875	13.9642	5.7989	2.29003	5.12821	612.61	29864.8
196	38416	7529536	14.0000	5.8088	2.29226	5.10204	615.75	30171.9
197	38809	7645373	14.0357	5.8186	2.29447	5.07614	618.89	30480.5
198	39204	7762392	14.0712	5.8285	2.29667	5.05051	622.04	30790.7
199	39601	7880599	14.1067	5.8383	2.29885	5.02513	625.18	31102.6

200 TO 249 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
200	40000	8000000	14.1421	5.8480	2.30103	5.00000	628.32	31415.9
201	40401	8120601	14.1774	5.8578	2.30320	4.97512	631.46	31730.9
202	40804	8242408	14.2127	5.8675	2.30535	4.95050	634.60	32047.4
203	41209	8365427	14.2478	5.8771	2.30750	4.92611	637.74	32365.5
204	41616	8489664	14.2829	5.8868	2.30963	4.90196	640.88	32685.1
205	42025	8615125	14.3178	5.8964	2.31175	4.87805	644.03	33006.4
206	42436	8741816	14.3527	5.9059	2.31387	4.85437	647.17	33329.2
207	42849	8869743	14.3875	5.9155	2.31597	4.83092	650.31	33653.5
208	43264	8998912	14.4222	5.9250	2.31806	4.80769	653.45	33979.5
209	43681	9129329	14.4568	5.9345	2.32015	4.78469	656.59	34307.0
210	44100	9261000	14.4914	5.9439	2.32222	4.76190	659.73	34636.1
211	44521	9393931	14.5258	5.9533	2.32428	4.73934	662.88	34966.7
212	44944	9528128	14.5602	5.9627	2.32634	4.71698	666.02	35298.9
213	45369	9663597	14.5945	5.9721	2.32838	4.69484	669.16	35632.7
214	45796	9800344	14.6287	5.9814	2.33041	4.67290	672.30	35968.1
215	46225	9938375	14.6629	5.9907	2.33244	4.65116	675.44	36305.0
216	46656	10077696	14.6969	6.0000	2.33445	4.62963	678.58	36643.5
217	47089	10218313	14.7309	6.0092	2.33646	4.60829	681.73	36983.6
218	47524	10360232	14.7648	6.0185	2.33846	4.58716	684.87	37325.3
219	47961	10503459	14.7986	6.0277	2.34044	4.56621	688.01	37668.5
220	48400	10648000	14.8324	6.0368	2.34242	4.54545	691.15	38013.3
221	48841	10793861	14.8661	6.0459	2.34439	4.52489	694.29	38359.6
222	49284	10941048	14.8997	6.0550	2.34635	4.50450	697.43	38707.6
223	49729	11089567	14.9332	6.0641	2.34830	4.48430	700.58	39057.1
224	50176	11239424	14.9666	6.0732	2.35025	4.46429	703.72	39408.1
225	50625	11390625	15.0000	6.0822	2.35218	4.44444	706.86	39760.8
226	51076	11543176	15.0333	6.0912	2.35411	4.42478	710.00	40115.0
227	51529	11697083	15.0665	6.1002	2.35603	4.40529	713.14	40470.8
228	51984	11852352	15.0997	6.1091	2.35793	4.38596	716.28	40828.1
229	52441	12008989	15.1327	6.1180	2.35984	4.36681	719.42	41187.1
230	52900	12167000	15.1658	6.1269	2.36173	4.34783	722.57	41547.6
231	53361	12326391	15.1987	6.1358	2.36361	4.32900	725.71	41909.6
232	53824	12487168	15.2315	6.1446	2.36549	4.31034	728.85	42273.3
233	54289	12649337	15.2643	6.1534	2.36736	4.29185	731.99	42638.5
234	54756	12812904	15.2971	6.1622	2.36922	4.27350	735.13	43005.3
235	55225	12977875	15.3297	6.1710	2.37107	4.25532	738.27	43373.6
236	55696	13144256	15.3623	6.1797	2.37291	4.23729	741.42	43743.5
237	56169	13312053	15.3948	6.1885	2.37475	4.21941	744.56	44115.0
238	56644	13481272	15.4272	6.1972	2.37658	4.20168	747.70	44488.1
239	57121	13651919	15.4596	6.2058	2.37840	4.18410	750.84	44862.7
240	57600	13824000	15.4919	6.2145	2.38021	4.16667	753.98	45238.9
241	58081	13997521	15.5242	6.2231	2.38202	4.14938	757.12	45616.7
242	58564	14172488	15.5563	6.2317	2.38382	4.13223	760.27	45996.1
243	59049	14348907	15.5885	6.2403	2.38561	4.11523	763.41	46377.0
244	59536	14526784	15.6205	6.2488	2.38739	4.09836	766.55	46759.5
245	60025	14706125	15.6525	6.2573	2.38917	4.08163	769.69	47143.5
246	60516	14886936	15.6844	6.2658	2.39094	4.06504	772.83	47529.2
247	61009	15069223	15.7162	6.2743	2.39270	4.04858	775.97	47916.4
248	61504	15252992	15.7480	6.2828	2.39445	4.03226	779.12	48305.1
249	62001	15438249	15.7797	6.2912	2.39620	4.01606	782.26	48695.5

FUNCTIONS OF NUMBERS 250 TO 299

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
250	62500	15625000	15.8114	6.2996	2.39794	4.00000	785.40	49087.4
251	63001	15813251	15.8430	6.3080	2.39967	3.98406	788.54	49480.9
252	63504	16003008	15.8745	6.3164	2.40140	3.96825	791.68	49875.9
253	64009	16194277	15.9060	6.3247	2.40312	3.95257	794.82	50272.6
254	64516	16387064	15.9374	6.3330	2.40483	3.93701	797.96	50670.7
255	65025	16581375	15.9687	6.3413	2.40654	3.92157	801.11	51070.5
256	65536	16777216	16.0000	6.3496	2.40824	3.90625	804.25	51471.9
257	66049	16974593	16.0312	6.3579	2.40993	3.89105	807.39	51874.8
258	66564	17173512	16.0624	6.3661	2.41162	3.87597	810.53	52279.2
259	67081	17373979	16.0935	6.3743	2.41330	3.86100	813.67	52685.3
260	67600	17576000	16.1245	6.3825	2.41497	3.84615	816.81	53092.9
261	68121	17779581	16.1555	6.3907	2.41664	3.83142	819.96	53502.1
262	68644	17984728	16.1864	6.3988	2.41830	3.81679	823.10	53912.9
263	69169	18191447	16.2173	6.4070	2.41996	3.80228	826.24	54325.2
264	69696	18399744	16.2481	6.4151	2.42160	3.78788	829.38	54739.1
265	70225	18609625	16.2788	6.4232	2.42325	3.77358	832.52	55154.6
266	70756	18821096	16.3095	6.4312	2.42488	3.75940	835.66	55571.6
267	71289	19034163	16.3401	6.4393	2.42651	3.74532	838.81	55990.2
268	71824	19248832	16.3707	6.4473	2.42813	3.73134	841.95	56410.4
269	72361	19465109	16.4012	6.4553	2.42975	3.71747	845.09	56832.2
270	72900	19683000	16.4317	6.4633	2.43136	3.70370	848.23	57255.5
271	73441	19902511	16.4621	6.4713	2.43297	3.69004	851.37	57680.4
272	73984	20123648	16.4924	6.4792	2.43457	3.67647	854.51	58106.9
273	74529	20346417	16.5227	6.4872	2.43616	3.66300	857.65	58534.9
274	75076	20570824	16.5529	6.4951	2.43775	3.64964	860.80	58964.6
275	75625	20796875	16.5831	6.5030	2.43933	3.63636	863.94	59395.7
276	76176	21024576	16.6132	6.5108	2.44091	3.62319	867.08	59828.5
277	76729	21253933	16.6433	6.5187	2.44248	3.61011	870.22	60262.8
278	77284	21484952	16.6733	6.5265	2.44404	3.59712	873.36	60698.7
279	77841	21717639	16.7033	6.5343	2.44560	3.58423	876.50	61136.2
280	78400	21952000	16.7332	6.5421	2.44716	3.57143	879.65	61575.2
281	78961	22188041	16.7631	6.5499	2.44871	3.55872	882.79	62015.8
282	79524	22425768	16.7929	6.5577	2.45025	3.54610	885.93	62458.0
283	80089	22665187	16.8226	6.5654	2.45179	3.53357	889.07	62901.8
284	80656	22906304	16.8523	6.5731	2.45332	3.52113	892.21	63347.1
285	81225	23149125	16.8819	6.5808	2.45484	3.50877	895.35	63794.0
286	81796	23393656	16.9115	6.5885	2.45637	3.49650	898.50	64242.4
287	82369	23639903	16.9411	6.5962	2.45788	3.48432	901.64	64692.5
288	82944	23887872	16.9706	6.6039	2.45939	3.47222	904.78	65144.1
289	83521	24137569	17.0000	6.6115	2.46090	3.46021	907.92	65597.2
290	84100	24389000	17.0294	6.6191	2.46240	3.44828	911.06	66052.0
291	84681	24642171	17.0587	6.6267	2.46389	3.43643	914.20	66508.3
292	85264	24897088	17.0880	6.6343	2.46538	3.42466	917.35	66966.2
293	85849	25153757	17.1172	6.6419	2.46687	3.41297	920.49	67425.6
294	86436	25412184	17.1464	6.6494	2.46835	3.40136	923.63	67886.7
295	87025	25672375	17.1756	6.6569	2.46982	3.38983	926.77	68349.3
296	87616	25934336	17.2047	6.6644	2.47129	3.37838	929.91	68813.4
297	88209	26198073	17.2337	6.6719	2.47276	3.36700	933.05	69279.2
298	88804	26463592	17.2627	6.6794	2.47422	3.35570	936.19	69746.5
299	89401	26730899	17.2916	6.6869	2.47567	3.34448	939.34	70215.4

300 TO 349 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
300	90000	27000000	17.3205	6.6943	2.47712	3.33333	942.48	70685.8
301	90601	27270901	17.3494	6.7018	2.47857	3.32226	945.62	71157.9
302	91204	27543608	17.3781	6.7092	2.48001	3.31126	948.76	71631.5
303	91809	27818127	17.4069	6.7166	2.48144	3.30033	951.90	72106.6
304	92416	28094464	17.4356	6.7240	2.48287	3.28947	955.04	72583.4
305	93025	28372625	17.4642	6.7313	2.48430	3.27869	958.19	73061.7
306	93636	28652616	17.4929	6.7387	2.48572	3.26797	961.33	73541.5
307	94249	28934443	17.5214	6.7460	2.48714	3.25733	964.47	74023.0
308	94864	29218112	17.5499	6.7533	2.48855	3.24675	967.61	74506.0
309	95481	29503629	17.5784	6.7606	2.48996	3.23625	970.75	74990.6
310	96100	29791000	17.6068	6.7679	2.49136	3.22581	973.89	75476.8
311	96721	30080231	17.6352	6.7752	2.49276	3.21543	977.04	75964.5
312	97344	30371328	17.6635	6.7824	2.49415	3.20513	980.18	76453.8
313	97969	30664297	17.6918	6.7897	2.49554	3.19489	983.32	76944.7
314	98596	30959144	17.7200	6.7969	2.49693	3.18471	986.46	77437.1
315	99225	31255875	17.7482	6.8041	2.49831	3.17460	989.60	77931.1
316	99856	31554496	17.7764	6.8113	2.49969	3.16456	992.74	78426.7
317	100489	31855013	17.8045	6.8185	2.50106	3.15457	995.88	78923.9
318	101124	32157432	17.8326	6.8256	2.50243	3.14465	999.03	79422.6
319	101761	32461759	17.8606	6.8328	2.50379	3.13480	1002.2	79922.9
320	102400	32768000	17.8885	6.8399	2.50515	3.12500	1005.3	80424.8
321	103041	33076161	17.9165	6.8470	2.50651	3.11526	1008.5	80928.2
322	103684	33386248	17.9444	6.8541	2.50786	3.10559	1011.6	81433.2
323	104329	33698267	17.9722	6.8612	2.50920	3.09598	1014.7	81939.8
324	104976	34012224	18.0000	6.8683	2.51055	3.08642	1017.9	82448.0
325	105625	34328125	18.0278	6.8753	2.51188	3.07692	1021.0	82957.7
326	106276	34645976	18.0555	6.8824	2.51322	3.06749	1024.2	83469.0
327	106929	34965783	18.0831	6.8894	2.51455	3.05810	1027.3	83981.8
328	107584	35287552	18.1108	6.8964	2.51587	3.04878	1030.4	84496.3
329	108241	35611289	18.1384	6.9034	2.51720	3.03951	1033.6	85012.3
330	108900	35937000	18.1659	6.9104	2.51851	3.03030	1036.7	85529.9
331	109561	36264691	18.1934	6.9174	2.51983	3.02115	1039.9	86049.0
332	110224	36594368	18.2209	6.9244	2.52114	3.01205	1043.0	86569.7
333	110889	36926037	18.2483	6.9313	2.52244	3.00300	1046.2	87092.0
334	111556	37259704	18.2757	6.9382	2.52375	2.99401	1049.3	87615.9
335	112225	37595375	18.3030	6.9451	2.52504	2.98507	1052.4	88141.3
336	112896	37933056	18.3303	6.9521	2.52634	2.97619	1055.6	88668.3
337	113569	38272753	18.3576	6.9589	2.52763	2.96736	1058.7	89196.9
338	114244	38614472	18.3848	6.9658	2.52892	2.95858	1061.9	89727.0
339	114921	38958219	18.4120	6.9727	2.53020	2.94985	1065.0	90258.7
340	115600	39304000	18.4391	6.9795	2.53148	2.94118	1068.1	90792.0
341	116281	39651821	18.4662	6.9864	2.53275	2.93255	1071.3	91326.9
342	116964	40001688	18.4932	6.9932	2.53403	2.92398	1074.4	91863.3
343	117649	40353607	18.5203	7.0000	2.53529	2.91545	1077.6	92401.3
344	118336	40707584	18.5472	7.0068	2.53656	2.90698	1080.7	92940.9
345	119025	41063625	18.5742	7.0136	2.53782	2.89855	1083.8	93482.0
346	119716	41421736	18.6011	7.0203	2.53908	2.89017	1087.0	94024.7
347	120409	41781923	18.6279	7.0271	2.54033	2.88184	1090.1	94569.0
348	121104	42144192	18.6548	7.0338	2.54158	2.87356	1093.3	95114.9
349	121801	42508549	18.6815	7.0406	2.54283	2.86533	1096.4	95662.3

FUNCTIONS OF NUMBERS 350 TO 399

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
350	122500	42875000	18.7083	7.0473	2.54407	2.85714	1099.6	96211.3
351	123201	43243551	18.7350	7.0540	2.54531	2.84900	1102.7	96761.8
352	123904	43614208	18.7617	7.0607	2.54654	2.84091	1105.8	97314.0
353	124609	43986977	18.7883	7.0674	2.54777	2.83286	1109.0	97867.7
354	125316	44361864	18.8149	7.0740	2.54900	2.82486	1112.1	98423.0
355	126025	44738875	18.8414	7.0807	2.55023	2.81690	1115.3	98979.8
356	126736	45118016	18.8680	7.0873	2.55145	2.80899	1118.4	99538.2
357	127449	45499293	18.8944	7.0940	2.55267	2.80112	1121.5	100098
358	128164	45882712	18.9209	7.1006	2.55388	2.79330	1124.7	100660
359	128881	46268279	18.9473	7.1072	2.55509	2.78552	1127.8	101223
360	129600	46656000	18.9737	7.1138	2.55630	2.77778	1131.0	101788
361	130321	47045881	19.0000	7.1204	2.55751	2.77008	1134.1	102354
362	131044	47437928	19.0263	7.1269	2.55871	2.76243	1137.3	102922
363	131769	47832147	19.0526	7.1335	2.55991	2.75482	1140.4	103491
364	132496	48228544	19.0788	7.1400	2.56110	2.74725	1143.5	104062
365	133225	48627125	19.1050	7.1466	2.56229	2.73973	1146.7	104635
366	133956	49027896	19.1311	7.1531	2.56348	2.73224	1149.8	105209
367	134689	49430863	19.1572	7.1596	2.56467	2.72480	1153.0	105785
368	135424	49836032	19.1833	7.1661	2.56585	2.71739	1156.1	106362
369	136161	50243409	19.2094	7.1726	2.56703	2.71003	1159.2	106941
370	136900	50653000	19.2354	7.1791	2.56820	2.70270	1162.4	107521
371	137641	51064811	19.2614	7.1855	2.56937	2.69542	1165.5	108103
372	138384	51478848	19.2873	7.1920	2.57054	2.68817	1168.7	108687
373	139129	51895117	19.3132	7.1984	2.57171	2.68097	1171.8	109272
374	139876	52313624	19.3391	7.2048	2.57287	2.67380	1175.0	109858
375	140625	52734375	19.3649	7.2112	2.57403	2.66667	1178.1	110447
376	141376	53157376	19.3907	7.2177	2.57519	2.65957	1181.2	111036
377	142129	53582633	19.4165	7.2240	2.57634	2.65252	1184.4	111628
378	142884	54010152	19.4422	7.2304	2.57749	2.64550	1187.5	112221
379	143641	54439939	19.4679	7.2368	2.57864	2.63852	1190.7	112815
380	144400	54872000	19.4936	7.2432	2.57978	2.63158	1193.8	113411
381	145161	55306341	19.5192	7.2495	2.58093	2.62467	1196.9	114009
382	145924	55742968	19.5448	7.2558	2.58206	2.61780	1200.1	114608
383	146689	56181887	19.5704	7.2622	2.58320	2.61097	1203.2	115209
384	147456	56623104	19.5959	7.2685	2.58433	2.60417	1206.4	115812
385	148225	57066625	19.6214	7.2748	2.58546	2.59740	1209.5	116416
386	148996	57512456	19.6469	7.2811	2.58659	2.59067	1212.7	117021
387	149769	57960603	19.6723	7.2874	2.58771	2.58398	1215.8	117628
388	150544	58411072	19.6977	7.2936	2.58883	2.57732	1218.9	118237
389	151321	58863869	19.7231	7.2999	2.58995	2.57069	1222.1	118847
390	152100	59319000	19.7484	7.3061	2.59106	2.56410	1225.2	119459
391	152881	59776471	19.7737	7.3124	2.59218	2.55754	1228.4	120072
392	153664	60236288	19.7990	7.3186	2.59329	2.55102	1231.5	120687
393	154449	60698457	19.8242	7.3248	2.59439	2.54453	1234.6	121304
394	155236	61162984	19.8494	7.3310	2.59550	2.53807	1237.8	121922
395	156025	61629875	19.8746	7.3372	2.59660	2.53165	1240.9	122542
396	156816	62099136	19.8997	7.3434	2.59770	2.52525	1244.1	123163
397	157609	62570773	19.9249	7.3496	2.59879	2.51889	1247.2	123786
398	158404	63044792	19.9499	7.3558	2.59988	2.51256	1250.4	124410
399	159201	63521199	19.9750	7.3619	2.60097	2.50627	1253.5	125036

400 TO 449 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
400	160000	64000000	20.0000	7.3681	2.60206	2.50000	1256.6	125664
401	160801	64481201	20.0250	7.3742	2.60314	2.49377	1259.8	126293
402	161604	64964808	20.0499	7.3803	2.60423	2.48756	1262.9	126923
403	162409	65450827	20.0749	7.3864	2.60531	2.48139	1266.1	127556
404	163216	65939264	20.0998	7.3925	2.60638	2.47525	1269.2	128190
405	164025	66430125	20.1246	7.3986	2.60746	2.46914	1272.3	128825
406	164836	66923416	20.1494	7.4047	2.60853	2.46305	1275.5	129462
407	165649	67419143	20.1742	7.4108	2.60959	2.45700	1278.6	130100
408	166464	67917312	20.1990	7.4169	2.61066	2.45098	1281.8	130741
409	167281	68417929	20.2237	7.4229	2.61172	2.44499	1284.9	131382
410	168100	68921000	20.2485	7.4290	2.61278	2.43902	1288.1	132025
411	168921	69426531	20.2731	7.4350	2.61384	2.43309	1291.2	132670
412	169744	69934528	20.2978	7.4410	2.61490	2.42718	1294.3	133317
413	170569	70444997	20.3224	7.4470	2.61595	2.42131	1297.5	133965
414	171396	70957944	20.3470	7.4530	2.61700	2.41546	1300.6	134614
415	172225	71473375	20.3715	7.4590	2.61805	2.40964	1303.8	135265
416	173056	71991296	20.3961	7.4650	2.61909	2.40385	1306.9	135918
417	173889	72511713	20.4206	7.4710	2.62014	2.39808	1310.0	136572
418	174724	73034632	20.4450	7.4770	2.62118	2.39234	1313.2	137228
419	175561	73560059	20.4695	7.4829	2.62221	2.38663	1316.3	137885
420	176400	74088000	20.4939	7.4889	2.62325	2.38095	1319.5	138544
421	177241	74618461	20.5183	7.4948	2.62428	2.37530	1322.6	139205
422	178084	75151448	20.5426	7.5007	2.62531	2.36967	1325.8	139867
423	178929	75686967	20.5670	7.5067	2.62634	2.36407	1328.9	140531
424	179776	76225024	20.5913	7.5126	2.62737	2.35849	1332.0	141196
425	180625	76765625	20.6155	7.5185	2.62839	2.35294	1335.2	141863
426	181476	77308776	20.6398	7.5244	2.62941	2.34742	1338.3	142531
427	182329	77854483	20.6640	7.5302	2.63043	2.34192	1341.5	143201
428	183184	78402752	20.6882	7.5361	2.63144	2.33645	1344.6	143872
429	184041	78953589	20.7123	7.5420	2.63246	2.33100	1347.7	144545
430	184900	79507000	20.7364	7.5478	2.63347	2.32558	1350.9	145220
431	185761	80062991	20.7605	7.5537	2.63448	2.32019	1354.0	145896
432	186624	80621568	20.7846	7.5595	2.63548	2.31481	1357.2	146574
433	187489	81182737	20.8087	7.5654	2.63649	2.30947	1360.3	147254
434	188356	81746504	20.8327	7.5712	2.63749	2.30415	1363.5	147934
435	189225	82312875	20.8567	7.5770	2.63849	2.29885	1366.6	148617
436	190096	82881856	20.8806	7.5828	2.63949	2.29358	1369.7	149301
437	190969	83453453	20.9045	7.5886	2.64048	2.28833	1372.9	149987
438	191844	84027672	20.9284	7.5944	2.64147	2.28311	1376.0	150674
439	192721	84604519	20.9523	7 6001	2.64246	2.27790	1379.2	151363
440	193600	85184000	20.9762	7.6059	2.64345	2.27273	1382.3	152053
441	194481	85766121	21.0000	7.6117	2.64444	2.26757	1385.4	152745
442	195364	86350888	21.0238	7.6174	2.64542	2.26244	1388.6	153439
443	196249	86938307	21.0476	7.6232	2.64640	2.25734	1391.7	154134
444	197136	87528384	21.0713	7 6289	2 64738	2.25225	1394.9	154830
445	198025	88121125	21.0950	7.6346	2.64836	2.24719	1398.0	155528
446	198916	88716536	21.1187	7.6403	2.64933	2.24215	1401.2	156228
447	199809	89314623	21.1424	7.6460	2.65031	2.23714	1404.3	156930
448	200704	89915392	21.1660	7.6517	2.65128	2.23214	1407.4	157633
449	201601	90518849	21.1896	7.6574	2.65225	2.22717	1410.6	158337

FUNCTIONS OF NUMBERS 450 TO 499

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
450	202500	91125000	21.2132	7.6631	2.65321	2.22222	1413.7	159043
451	203401	91733851	21.2368	7.6688	2.65418	2.21729	1416.9	159751
452	204304	92345408	21.2603	7.6744	2.65514	2.21239	1420.0	160460
453	205209	92959677	21.2838	7.6801	2.65610	2.20751	1423.1	161171
454	206116	93576664	21.3073	7.6857	2.65706	2.20264	1426.3	161883
455	207025	94196375	21.3307	7.6914	2.65801	2.19780	1429.4	162597
456	207936	94818816	21.3542	7.6970	2.65896	2.19298	1432.6	163313
457	208849	95443993	21.3776	7.7026	2.65992	2.18818	1435.7	164030
458	209764	96071912	21.4009	7.7082	2.66087	2.18341	1438.8	164748
459	210681	96702579	21.4243	7.7138	2.66181	2.17865	1442.0	165468
460	211600	97336000	21.4476	7.7194	2.66276	2.17391	1445.1	166190
461	212521	97972181	21.4709	7.7250	2.66370	2.16920	1448.3	166914
462	213444	98611128	21.4942	7.7306	2.66464	2.16450	1451.4	167639
463	214369	99252847	21.5174	7.7362	2.66558	2.15983	1454.6	168365
464	215296	99897344	21.5407	7.7418	2.66652	2.15517	1457.7	169093
465	216225	100544625	21.5639	7.7473	2.66745	2.15054	1460.8	169823
466	217156	101194696	21.5870	7.7529	2.66839	2.14592	1464.0	170554
467	218089	101847563	21.6102	7.7584	2.66932	2.14133	1467.1	171287
468	219024	102503232	21.6333	7.7639	2.67025	2.13675	1470.3	172021
469	219961	103161709	21.6564	7.7695	2.67117	2.13220	1473.4	172757
470	220900	103823000	21.6795	7.7750	2.67210	2.12766	1476.5	173494
471	221841	104487111	21.7025	7.7805	2.67302	2.12314	1479.7	174234
472	222784	105154048	21.7256	7.7860	2.67394	2.11864	1482.8	174974
473	223729	105823817	21.7486	7.7915	2.67486	2.11416	1486.0	175716
474	224676	106496424	21.7715	7.7970	2.67578	2.10970	1489.1	176460
475	225625	107171875	21.7945	7.8025	2.67669	2.10526	1492.3	177205
476	226576	107850176	21.8174	7.8079	2.67761	2.10084	1495.4	177952
477	227529	108531333	21.8403	7.8134	2.67852	2.09644	1498.5	178701
478	228484	109215352	21.8632	7.8188	2.67943	2.09205	1501.7	179451
479	229441	109902239	21.8861	7.8243	2.68034	2.08768	1504.8	180203
480	230400	110592000	21.9089	7.8297	2.68124	2.08333	1508.0	180956
481	231361	111284641	21.9317	7.8352	2.68215	2.07900	1511.1	181711
482	232324	111980168	21.9545	7.8406	2.68305	2.07469	1514.2	182467
483	233289	112678587	21.9773	7.8460	2.68395	2.07039	1517.4	183225
484	234256	113379904	22.0000	7.8514	2.68485	2.06612	1520.5	183984
485	235225	114084125	22.0227	7.8568	2.68574	2.06186	1523.7	184745
486	236196	114791256	22.0454	7.8622	2.68664	2.05761	1526.8	185508
487	237169	115501303	22.0681	7.8676	2.68753	2.05339	1530.0	186272
488	238144	116214272	22.0907	7.8730	2.68842	2.04918	1533.1	187038
489	239121	116930169	22.1133	7.8784	2.68931	2.04499	1536.2	187805
490	240100	117649000	22.1359	7.8837	2.69020	2.04082	1539.4	188574
491	241081	118370771	22.1585	7.8891	2.69108	2.03666	1542.5	189345
492	242064	119095488	22.1811	7.8944	2.69197	2.03252	1545.7	190117
493	243049	119823157	22.2036	7.8998	2.69285	2.02840	1548.8	190890
494	244036	120553784	22.2261	7.9051	2.69373	2.02429	1551.9	191665
495	245025	121287375	22.2486	7.9105	2.69461	2.02020	1555.1	192442
496	246016	122023936	22.2711	7.9158	2.69548	2.01613	1558.2	193221
497	247009	122763473	22.2935	7.9211	2.69636	2.01207	1561.4	194000
498	248004	123505992	22.3159	7.9264	2.69723	2.00803	1564.5	194782
499	249001	124251499	22.3383	7.9317	2.69810	2.00401	1567.7	195565

500 TO 549 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
500	250000	125000000	22.3607	7.9370	2.69897	2.00000	1570.8	196350
501	251001	125751501	22.3830	7.9423	2.69984	1.99601	1573.9	197136
502	252004	126506008	22.4054	7.9476	2.70070	1.99203	1577.1	197923
503	253009	127263527	22.4277	7.9528	2.70157	1.98807	1580.2	198713
504	254016	128024064	22.4499	7.9581	2.70243	1.98413	1583.4	199504
505	255025	128787625	22.4722	7.9634	2.70329	1.98020	1586.5	200296
506	256036	129554216	22.4944	7.9686	2.70415	1.97628	1589.6	201090
507	257049	130323843	22.5167	7.9739	2.70501	1.97239	1592.8	201886
508	258064	131096512	22.5389	7.9791	2.70586	1.96850	1595.9	202683
509	259081	131872229	22.5610	7.9843	2.70672	1.96464	1599.1	203482
510	260100	132651000	22.5832	7.9896	2.70757	1.96078	1602.2	204282
511	261121	133432831	22.6053	7.9948	2.70842	1.95695	1605.4	205084
512	262144	134217728	22.6274	8.0000	2.70927	1.95312	1608.5	205887
513	263169	135005697	22.6495	8.0052	2.71012	1.94932	1611.6	206692
514	264196	135796744	22.6716	8.0104	2.71096	1.94553	1614.8	207499
515	265225	136590875	22.6936	8.0156	2.71181	1.94175	1617.9	208307
516	266256	137388096	22.7156	8.0208	2.71265	1.93798	1621.1	209117
517	267289	138188413	22.7376	8.0260	2.71349	1.93424	1624.2	209928
518	268324	138991832	22.7596	8.0311	2.71433	1.93050	1627.3	210741
519	269361	139798359	22.7816	8.0363	2.71517	1.92678	1630.5	211556
520	270400	140608000	22.8035	8.0415	2.71600	1.92308	1633.6	212372
521	271441	141420761	22.8254	8.0466	2.71684	1.91939	1636.8	213189
522	272484	142236648	22.8473	8.0517	2.71767	1.91571	1639.9	214008
523	273529	143055667	22.8692	8.0569	2.71850	1.91205	1643.1	214829
524	274576	143877824	22.8910	8.0620	2.71933	1.90840	1646.2	215651
525	275625	144703125	22.9129	8.0671	2.72016	1.90476	1649.3	216475
526	276676	145531576	22.9347	8.0723	2.72099	1.90114	1652.5	217301
527	277729	146363183	22.9565	8.0774	2.72181	1.89753	1655.6	218128
528	278784	147197952	22.9783	8.0825	2.72263	1.89394	1658.8	218956
529	279841	148035889	23.0000	8.0876	2.72346	1.89036	1661.9	219787
530	280900	148877000	23.0217	8.0927	2.72428	1.88679	1665.0	220618
531	281961	149721291	23.0434	8.0978	2.72509	1.88324	1668.2	221452
532	283024	150568768	23.0651	8.1028	2.72591	1.87970	1671.3	222287
533	284089	151419437	23.0868	8.1079	2.72673	1.87617	1674.5	223123
534	285156	152273304	23.1084	8.1130	2.72754	1.87266	1677.6	223961
535	286225	153130375	23.1301	8.1180	2.72835	1.86916	1680.8	224801
536	287296	153990656	23.1517	8.1231	2.72916	1.86567	1683.9	225642
537	288369	154854153	23.1733	8.1281	2.72997	1.86220	1687.0	226484
538	289444	155720872	23.1948	8.1332	2.73078	1.85874	1690.2	227329
539	290521	156590819	23.2164	8.1382	2.73159	1.85529	1693.3	228175
540	291600	157464000	23.2379	8.1433	2.73239	1.85185	1696.5	229022
541	292681	158340421	23.2594	8.1483	2.73320	1.84843	1699.6	229871
542	293764	159220088	23.2809	8.1533	2.73400	1.84502	1702.7	230722
543	294849	160103007	23.3024	8.1583	2.73480	1.84162	1705.9	231574
544	295936	160989184	23.3238	8.1633	2.73560	1.83824	1709.0	232428
545	297025	161878625	23.3452	8.1683	2.73640	1.83486	1712.2	233283
546	298116	162771336	23.3666	8.1733	2.73719	1.83150	1715.3	234140
547	299209	163667323	23.3880	8.1783	2.73799	1.82815	1718.5	234998
548	300304	164566592	23.4094	8.1833	2.73878	1.82482	1721.6	235858
549	301401	165469149	23.4307	8.1882	2.73957	1.82149	1724.7	236720

FUNCTIONS OF NUMBERS 550 TO 599

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
550	302500	166375000	23.4521	8.1932	2.74036	1.81818	1727.9	237583
551	303601	167284151	23.4734	8.1982	2.74115	1.81488	1731.0	238448
552	304704	168196608	23.4947	8.2031	2.74194	1.81159	1734.2	239314
553	305809	169112377	23.5160	8.2081	2.74273	1.80832	1737.3	240182
554	306916	170031464	23.5372	8.2130	2.74351	1.80505	1740.4	241051
555	308025	170953875	23.5584	8.2180	2.74429	1.80180	1743.6	241922
556	309136	171879616	23.5797	8.2229	2.74507	1.79856	1746.7	242795
557	310249	172808693	23.6008	8.2278	2.74586	1.79533	1749.9	243669
558	311364	173741112	23.6220	8.2327	2.74663	1.79211	1753.0	244545
559	312481	174676879	23.6432	8.2377	2.74741	1.78891	1756.2	245422
560	313600	175616000	23.6643	8.2426	2.74819	1.78571	1759.3	246301
561	314721	176558481	23.6854	8.2475	2.74896	1.78253	1762.4	247181
562	315844	177504328	23.7065	8.2524	2.74974	1.77936	1765.6	248063
563	316969	178453547	23.7276	8.2573	2.75051	1.77620	1768.7	248947
564	318096	179406144	23.7487	8.2621	2.75128	1.77305	1771.9	249832
565	319225	180362125	23.7697	8.2670	2.75205	1.76991	1775.0	250719
566	320356	181321496	23.7908	8.2719	2.75282	1.76678	1778.1	251607
567	321489	182284263	23.8118	8.2768	2.75358	1.76367	1781.3	252497
568	322624	183250432	23.8328	8.2816	2.75435	1.76056	1784.4	253388
569	323761	184220009	23.8537	8.2865	2.75511	1.75747	1787.6	254281
570	324900	185193000	23.8747	8.2913	2.75587	1.75439	1790.7	255176
571	326041	186169411	23.8956	8.2962	2.75664	1.75131	1793.8	256072
572	327184	187149248	23.9165	8.3010	2.75740	1.74825	1797.0	256970
573	328329	188132517	23.9374	8.3059	2.75815	1.74520	1800.1	257869
574	329476	189119224	23.9583	8.3107	2.75891	1.74216	1803.3	258770
575	330625	190109375	23.9792	8.3155	2.75967	1.73913	1806.4	259672
576	331776	191102976	24.0000	8.3203	2.76042	1.73611	1809.6	260576
577	332929	192100033	24.0208	8.3251	2.76118	1.73310	1812.7	261482
578	334084	193100552	24.0416	8.3300	2.76193	1.73010	1815.8	262389
579	335241	194104539	24.0624	8.3348	2.76268	1.72712	1819.0	263298
580	336400	195112000	24.0832	8.3396	2.76343	1.72414	1822.1	264208
581	337561	196122941	24.1039	8.3443	2.76418	1.72117	1825.3	265120
582	338724	197137368	24.1247	8.3491	2.76492	1.71821	1828.4	266033
583	339889	198155287	24.1454	8.3539	2.76567	1.71527	1831.6	266948
584	341056	199176704	24.1661	8.3587	2.76641	1.71233	1834.7	267865
585	342225	200201625	24.1868	8.3634	2.76716	1.70940	1837.8	268783
586	343396	201230056	24.2074	8.3682	2.76790	1.70648	1841.0	269703
587	344569	202262003	24.2281	8.3730	2.76864	1.70358	1844.1	270624
588	345744	203297472	24.2487	8.3777	2.76938	1.70068	1847.3	271547
589	346921	204336469	24.2693	8.3825	2.77012	1.69779	1850.4	272471
590	348100	205379000	24.2899	8.3872	2.77085	1.69492	1853.5	273397
591	349281	206425071	24.3105	8.3919	2.77159	1.69205	1856.7	274325
592	350464	207474688	24.3311	8.3967	2.77232	1.68919	1859.8	275254
593	351649	208527857	24.3516	8.4014	2.77305	1.68634	1863.0	276184
594	352836	209584584	24.3721	8.4061	2.77379	1.68350	1866.1	277117
595	354025	210644875	24.3926	8.4108	2.77452	1.68067	1869.2	278051
596	355216	211708736	24.4131	8.4155	2.77525	1.67785	1872.4	278986
597	356409	212776173	24.4336	8.4202	2.77597	1.67504	1875.5	279923
598	357604	213847192	24.4540	8.4249	2.77670	1.67224	1878.7	280862
599	358801	214921799	24.4745	8.4296	2.77743	1.66945	1881.8	281802

600 TO 649 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
600	360000	216000000	24.4949	8.4343	2.77815	1.66667	1885.0	282743
601	361201	217081801	24.5153	8.4390	2.77887	1.66389	1888.1	283687
602	362404	218167208	24.5357	8.4437	2.77960	1.66113	1891.2	284631
603	363609	219256227	24.5561	8.4484	2.78032	1.65837	1894.4	285578
604	364816	220348864	24.5764	8.4530	2.78104	1.65563	1897.5	286526
605	366025	221445125	24.5967	8.4577	2.78176	1.65289	1900.7	287475
606	367236	222545016	24.6171	8.4623	2.78247	1.65017	1903.8	288426
607	368449	223648543	24.6374	8.4670	2.78319	1.64745	1906.9	289379
608	369664	224755712	24.6577	8.4716	2.78390	1.64474	1910.1	290333
609	370881	225866529	24.6779	8.4763	2.78462	1.64204	1913.2	291289
610	372100	226981000	24.6982	8.4809	2.78533	1.63934	1916.4	292247
611	373321	228099131	24.7184	8.4856	2.78604	1.63666	1919.5	293206
612	374544	229220928	24.7386	8.4902	2.78675	1.63399	1922.7	294166
613	375769	230346397	24.7588	8.4948	2.78746	1.63132	1925.8	295128
614	376996	231475544	24.7790	8.4994	2.78817	1.62866	1928.9	296092
615	378225	232608375	24.7992	8.5040	2.78888	1.62602	1932.1	297057
616	379456	233744896	24.8193	8.5086	2.78958	1.62338	1935.2	298024
617	380689	234885113	24.8395	8.5132	2.79029	1.62075	1938.4	298992
618	381924	236029032	24.8596	8.5178	2.79099	1.61812	1941.5	299962
619	383161	237176659	24.8797	8.5224	2.79169	1.61551	1944.6	300934
620	384400	238328000	24.8998	8.5270	2.79239	1.61290	1947.8	301907
621	385641	239483061	24.9199	8.5316	2.79309	1.61031	1950.9	302882
622	386884	240641848	24.9399	8.5362	2.79379	1.60772	1954.1	303858
623	388129	241804367	24.9600	8.5408	2.79449	1.60514	1957.2	304836
624	389376	242970624	24.9800	8.5453	2.79518	1.60256	1960.4	305815
625	390625	244140625	25.0000	8.5499	2.79588	1.60000	1963.5	306796
626	391876	245314376	25.0200	8.5544	2.79657	1.59744	1966.6	307779
627	393129	246491883	25.0400	8.5590	2.79727	1.59490	1969.8	308763
628	394384	247673152	25.0599	8.5635	2.79796	1.59236	1972.9	309748
629	395641	248858189	25.0799	8.5681	2.79865	1.58983	1976.1	310736
630	396900	250047000	25.0998	8.5726	2.79934	1.58730	1979.2	311725
631	398161	251239591	25.1197	8.5772	2.80003	1.58479	1982.3	312715
632	399424	252435968	25.1396	8.5817	2.80072	1.58228	1985.5	313707
633	400689	253636137	25.1595	8.5862	2.80140	1.57978	1988.6	314700
634	401956	254840104	25.1794	8.5907	2.80209	1.57729	1991.8	315696
635	403225	256047875	25.1992	8.5952	2.80277	1.57480	1994.9	316692
636	404496	257259456	25.2190	8.5997	2.80346	1.57233	1998.1	317690
637	405769	258474853	25.2389	8.6043	2.80414	1.56986	2001.2	318690
638	407044	259694072	25.2587	8.6088	2.80482	1.56740	2004.3	319692
639	408321	260917119	25.2784	8.6132	2.80550	1.56495	2007 5	320695
640	409600	262144000	25.2982	8.6177	2.80618	1.56250	2010.6	321699
641	410881	263374721	25.3180	8.6222	2.80686	1.56006	2013.8	322705
642	412164	264609288	25.3377	8.6267	2.80754	1.55763	2016 9	323713
643	413449	265847707	25.3574	8.6312	2.80821	1.55521	2020.0	324722
644	414736	267089984	25.3772	8.6357	2.80889	1.55280	2023.2	325733
645	416025	268336125	25.3969	8.6401	2.80956	1.55039	2026.3	326745
646	417316	269586136	25.4165	8.6446	2.81023	1.54799	2029.5	327759
647	418609	270840023	25.4362	8.6490	2.81090	1.54560	2032.6	328775
648	419904	272097792	25.4558	8.6535	2.81158	1.54321	2035.8	329792
649	421201	273359449	25.4755	8.6579	2.81224	1.54083	2038.9	330810

FUNCTIONS OF NUMBERS 650 TO 699

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
650	422500	274625000	25.4951	8.6624	2.81291	1.53846	2042.0	331831
651	423801	275894451	25.5147	8.6668	2.81358	1.53610	2045.2	332853
652	425104	277167808	25.5343	8.6713	2.81425	1.53374	2048.3	333876
653	426409	278445077	25.5539	8.6757	2.81491	1.53139	2051.5	334901
654	427716	279726264	25.5734	8.6801	2.81558	1.52905	2054.6	335927
655	429025	281011375	25.5930	8.6845	2.81624	1.52672	2057.7	336955
656	430336	282300416	25.6125	8.6890	2.81690	1.52439	2060.9	337985
657	431649	283593393	25.6320	8.6934	2.81757	1.52207	2064.0	339016
658	432964	284890312	25.6515	8.6978	2.81823	1.51976	2067.2	340049
659	434281	286191179	25.6710	8.7022	2.81889	1.51745	2070.3	341084
660	435600	287496000	25.6905	8.7066	2.81954	1.51515	2073.5	342119
661	436921	288804781	25.7099	8.7110	2.82020	1.51286	2076.6	343157
662	438244	290117528	25.7294	8.7154	2.82086	1.51057	2079.7	344196
663	439569	291434247	25.7488	8.7198	2.82151	1.50830	2082.9	345237
664	440896	292754944	25.7682	8.7241	2.82217	1.50602	2086.0	346279
665	442225	294079625	25.7876	8.7285	2.82282	1.50376	2089.2	347323
666	443556	295408296	25.8070	8.7329	2.82347	1.50150	2092.3	348368
667	444889	296740963	25.8263	8.7373	2.82413	1.49925	2095.4	349415
668	446224	298077632	25.8457	8.7416	2.82478	1.49701	2098.6	350464
669	447561	299418309	25.8650	8.7460	2.82543	1.49477	2101.7	351514
670	448900	300763000	25.8844	8.7503	2.82607	1.49254	2104.9	352565
671	450241	302111711	25.9037	8.7547	2.82672	1.49031	2108.0	353618
672	451584	303464448	25.9230	8.7590	2.82737	1.48810	2111.2	354673
673	452929	304821217	25.9422	8.7634	2.82082	1.48588	2114.3	355730
674	454276	306182024	25.9615	8.7677	2.82866	1.48368	2117.4	356788
675	455625	307546875	25.9808	8.7721	2.82930	1.48148	2120.6	357847
676	456976	308915776	26.0000	8.7764	2.82995	1.47929	2123.7	358908
677	458329	310288733	26.0192	8.7807	2.83059	1.47710	2126.9	359971
678	459684	311665752	26.0384	8.7850	2.83123	1.47493	2130.0	361035
679	461041	313046839	26.0576	8.7893	2.83187	1.47275	2133.1	362101
680	462400	314432000	26.0768	8.7937	2.83251	1.47059	2136.3	363168
681	463761	315821241	26.0960	8.7980	2.83315	1.46843	2139.4	364237
682	465124	317214568	26.1151	8.8023	2.83378	1.46628	2142.6	365308
683	466489	318611987	26.1343	8.8066	2.83442	1.46413	2145.7	366380
684	467856	320013504	26.1534	8.8109	2.83506	1.46199	2148.8	367453
685	469225	321419125	26.1725	8.8152	2.83569	1.45985	2152.0	368528
686	470596	322828856	26.1916	8.8194	2.83632	1.45773	2155.1	369605
687	471969	324242703	26.2107	8.8237	2.83696	1.45560	2158.3	370684
688	473344	325660672	26.2298	8.8280	2.83759	1.45349	2161.4	371764
689	474721	327082769	26.2488	8.8323	2.83822	1.45138	2164.6	372845
690	476100	328509000	26.2679	8.8366	2.83885	1.44928	2167.7	373928
691	477481	329939371	26.2869	8.8408	2.83948	1.44718	2170.8	375013
692	478864	331373888	26.3059	8.8451	2.84011	1.44509	2174.0	376099
693	480249	332812557	26.3249	8.8493	2.84073	1.44300	2177.1	377187
694	481636	334255384	26.3439	8.8536	2.84136	1.44092	2180.3	378276
695	483025	335702375	26.3629	8.8578	2.84198	1.43885	2183.4	379367
696	484416	337153536	26.3818	8.8621	2.84261	1.43678	2186.5	380459
697	485809	338608873	26.4008	8.8663	2.84323	1.43472	2189.7	381553
698	487204	340068392	26.4197	8.8706	2.84386	1.43266	2192.8	382649
699	488601	341532099	26.4386	8.8748	2.84448	1.43062	2196.0	383746

700 TO 749 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
700	490000	343000000	26.4575	8.8790	2.84510	1.42857	2199.1	384845
701	491401	344472101	26.4764	8.8833	2.84572	1.42653	2202.3	385945
702	492804	345948408	26.4953	8.8875	2.84634	1.42450	2205.4	387047
703	494209	347428927	26.5141	8.8917	2.84696	1.42248	2208.5	388151
704	495616	348913664	26.5330	8.8959	2.84757	1.42045	2211.7	389256
705	497025	350402625	26.5518	8.9001	2.84819	1.41844	2214.8	390363
706	498436	351895816	26.5707	8.9043	2.84880	1.41643	2218.0	391471
707	499849	353393243	26.5895	8.9085	2.84942	1.41443	2221.1	392580
708	501264	354894912	26.6083	8.9127	2.85003	1.41243	2224.2	393692
709	502681	356400829	26.6271	8.9169	2.85065	1.41044	2227.4	394805
710	504100	357911000	26.6458	8.9211	2.85126	1.40845	2230.5	395919
711	505521	359425431	26.6646	8.9253	2.85187	1.40647	2233.7	397035
712	506944	360944128	26.6833	8.9295	2.85248	1.40449	2236.8	398153
713	508369	362467097	26.7021	8.9337	2.85309	1.40252	2240.0	399272
714	509796	363994344	26.7208	8.9378	2.85370	1.40056	2243.1	400393
715	511225	365525875	26.7395	8.9420	2.85431	1.39860	2246.2	401515
716	512656	367061696	26.7582	8.9462	2.85491	1.39665	2249.4	402639
717	514089	368601813	26.7769	8.9503	2.85552	1.39470	2252.5	403765
718	515524	370146232	26.7955	8.9545	2.85612	1.39276	2255.7	404892
719	516961	371694959	26.8142	8.9587	2.85673	1.39082	2258.8	406020
720	518400	373248000	26.8328	8.9628	2.85733	1.38889	2261.9	407150
721	519841	374805361	26.8514	8.9670	2.85794	1.38696	2265.1	408282
722	521284	376367048	26.8701	8.9711	2.85854	1.38504	2268.2	409415
723	522729	377933067	26.8887	8.9752	2.85914	1.38313	2271.4	410550
724	524176	379503424	26.9072	8.9794	2.85974	1.38122	2274.5	411687
725	525625	381078125	26.9258	8.9835	2.86034	1.37931	2277.7	412825
726	527076	382657176	26.9444	8.9876	2.86094	1.37741	2280.8	413965
727	528529	384240583	26.9629	8.9918	2.86153	1.37552	2283.9	415106
728	529984	385828352	26.9815	8.9959	2.86213	1.37363	2287.1	416248
729	531441	387420489	27.0000	9.0000	2.86273	1.37174	2290.2	417393
730	532900	389017000	27.0185	9.0041	2.86332	1.36986	2293.4	418539
731	534361	390617891	27.0370	9.0082	2.86392	1.36799	2296.5	419686
732	535824	392223168	27.0555	9.0123	2.86451	1.36612	2299.6	420835
733	537289	393832837	27.0740	9.0164	2.86510	1.36426	2302.8	421986
734	538756	395446904	27.0924	9.0205	2.86570	1.36240	2305.9	423138
735	540225	397065375	27.1109	9.0246	2.86629	1.36054	2309.1	424293
736	541696	398688256	27.1293	9.0287	2.86688	1.35870	2312.2	425447
737	543169	400315553	27.1477	9.0328	2.86747	1.35685	2315.4	426604
738	544644	401947272	27.1662	9.0369	2.86806	1.35501	2318.5	427762
739	546121	403583419	27.1846	9.0410	2.86864	1.35318	2321.6	428922
740	547600	405224000	27.2029	9.0450	2.86923	1.35135	2324.8	430084
741	549081	406869021	27.2213	9.0491	2.86982	1.34953	2327.9	431247
742	550564	408518488	27.2397	9.0532	2.87040	1.34771	2331.1	432412
743	552049	410172407	27.2580	9.0572	2.87099	1.34590	2334.2	433578
744	553536	411830784	27.2764	9.0613	2.87157	1.34409	2337.3	434746
745	555025	413493625	27.2947	9.0654	2.87216	1.34228	2340.5	435916
746	556516	415160936	27.3130	9.0694	2.87274	1.34048	2343.6	437087
747	558009	416832723	27.3313	9.0735	2.87332	1.33869	2346.8	438259
748	559504	418508992	27.3496	9.0775	2.87390	1.33690	2349.9	439433
749	561001	420189749	27.3679	9.0816	2.87448	1.33511	2353.1	440609

FUNCTIONS OF NUMBERS 750 TO 799

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
750	562500	421875000	27.3861	9.0856	2.87506	1.33333	2356.2	441786
751	564001	423564751	27.4044	9.0896	2.87564	1.33156	2359.3	442965
752	565504	425259008	27.4226	9.0937	2.87622	1.32979	2362.5	444146
753	567009	426957777	27.4408	9.0977	2.87680	1.32802	2365.6	445328
754	568516	428661064	27.4591	9.1017	2 87737	1.32626	2368.8	446511
755	570025	430368875	27.4773	9 1057	2.87795	1.32450	2371.9	447697
756	571536	432081216	27.4955	9.1098	2.87852	1.32275	2375.0	448883
757	573049	433798093	27.5136	9.1138	2.87910	1.32100	2378.2	450072
758	574564	435519512	27.5318	9.1178	2.87967	1.31926	2381.3	451262
759	576081	437245479	27.5500	9.1218	2.88024	1.31752	2384.5	452453
760	577600	438976000	27.5681	9.1258	2.88081	1.31579	2387.6	453646
761	579121	440711081	27.5862	9.1298	2.88138	1.31406	2390.8	454841
762	580644	442450728	27.6043	9.1338	2.88196	1.31234	2393.9	456037
763	582169	444194947	27.6225	9.1378	2.88252	1.31062	2397.0	457234
764	583696	445943744	27.6405	9.1418	2.88309	1.30890	2400.2	458434
765	585225	447697125	27.6586	9.1458	2.88366	1.30719	2403.3	459635
766	586756	449455096	27.6767	9.1498	2.88423	1.30548	2406.5	460837
767	588289	451217663	27.6948	9.1537	2.88480	1.30378	2409.6	462041
768	589824	452984832	27.7128	9.1577	2.88536	1.30208	2412.7	463247
769	591361	454756609	27.7308	9.1617	2.88593	1.30039	2415.9	464454
770	592900	456533000	27.7489	9.1657	2.88649	1.29870	2419.0	465663
771	594441	458314011	27.7669	9.1696	2.88705	1.29702	2422.2	466873
772	595984	460099648	27.7849	9.1736	2.88762	1.29534	2425.3	468085
773	597529	461889917	27.8029	9.1775	2.88818	1.29366	2428.5	469298
774	599076	463684824	27.8209	9.1815	2.88874	1.29199	2431.6	470513
775	600625	465484375	27.8388	9.1855	2.88930	1.29032	2434.7	471730
776	602176	467288576	27.8568	9.1894	2.88986	1.28866	2437.9	472948
777	603729	469097433	27.8747	9.1933	2.89042	1.28700	2441.0	474168
778	605284	470910952	27.8927	9.1973	2.89098	1.28535	2444.2	475389
779	606841	472729139	27.9106	9 2012	2.89154	1.28370	2447.3	476612
780	608400	474552000	27.9285	9.2052	2.89209	1.28205	2450.4	477836
781	609961	476379541	27 9464	9.2091	2.89265	1.28041	2453.6	479062
782	611524	478211768	27.9643	9.2130	2.89321	1.27877	2456.7	480290
783	613089	480048687	27.9821	9.2170	2.89376	1.27714	2459.9	481519
784	614656	481890304	28.0000	9.2209	2.89432	1.27551	2463.0	482750
785	616225	483736625	28.0179	9.2248	2.89487	1.27389	2466.2	483982
786	617796	485587656	28.0357	9.2287	2.89542	1.27226	2469.3	485216
787	619369	487443403	28.0535	9.2326	2.89597	1.27065	2472.4	486451
788	620944	489303872	28.0713	9.2365	2.89653	1.26904	2475.6	487688
789	622521	491169069	28.0891	9.2404	2.89708	1.26743	2478.7	488927
790	624100	493039000	28.1069	9.2443	2.89763	1.26582	2481.9	490167
791	625681	494913671	28.1247	9.2482	2.89818	1.26422	2485.0	491409
792	627264	496793088	28.1425	9.2521	2.89873	1.26263	2488.1	492652
793	628849	498677257	28.1603	9.2560	2.89927	1.26103	2491.3	493897
794	630436	500566184	28.1780	9.2599	2.89982	1.25945	2494.4	495143
795	632025	502459875	28.1957	9.2638	2.90037	1.25786	2497.6	496391
796	633616	504358336	28.2135	9.2677	2.90091	1.25628	2500 7	497641
797	635209	506261573	28.2312	9.2716	2.90146	1.25471	2503.8	498892
798	636804	508169592	28.2489	9.2754	2.90200	1.25313	2507.0	500145
799	638401	510082399	28.2666	9.2793	2.90255	1.25156	2510.1	501399

800 TO 849 FUNCTIONS OF NUMBERS

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
800	640000	512000000	28.2843	9.2832	2.90309	1.25000	2513.3	502655
801	641601	513922401	28.3019	9.2870	2.90363	1.24844	2516.4	503912
802	643204	515849608	28.3196	9.2909	2.90417	1.24688	2519.6	505171
803	644809	517781627	28.3373	9.2948	2.90472	1.24533	2522.7	506432
804	646416	519718464	28.3549	9.2986	2.90526	1.24378	2525.8	507694
805	648025	521660125	28.3725	9.3025	2.90580	1.24224	2529.0	508958
806	649636	523606616	28.3901	9.3063	2.90634	1.24069	2532.1	510223
807	651249	525557943	28.4077	9.3102	2.90687	1.23916	2535.3	511490
808	652864	527514112	28.4253	9.3140	2.90741	1.23762	2538.4	512758
809	654481	529475129	28.4429	9.3179	2.90795	1.23609	2541.5	514028
810	656100	531441000	28.4605	9.3217	2.90849	1.23457	2544.7	515300
811	657721	533411731	28.4781	9.3255	2.90902	1.23305	2547.8	516573
812	659344	535387328	28.4956	9.3294	2.90956	1.23153	2551.0	517848
813	660969	537367797	28.5132	9.3332	2.91009	1.23001	2554.1	519124
814	662596	539353144	28.5307	9.3370	2.91062	1.22850	2557.3	520402
815	664225	541343375	28.5482	9.3408	2.91116	1.22699	2560.4	521681
816	665856	543338496	28.5657	9.3447	2.91169	1.22549	2563.5	522962
817	667489	545338513	28.5832	9.3485	2.91222	1.22399	2566.7	524245
818	669124	547343432	28.6007	9.3523	2.91275	1.22249	2569.8	525529
819	670761	549353259	28.6182	9.3561	2.91328	1.22100	2573.0	526814
820	672400	551368000	28.6356	9.3599	2.91381	1.21951	2576.1	528102
821	674041	553387661	28.6531	9.3637	2.91434	1.21803	2579.2	529391
822	675684	555412248	28.6705	9.3675	2.91487	1.21655	2582.4	530681
823	677329	557441767	28.6880	9.3713	2.91540	1.21507	2585.5	531973
824	678976	559476224	28.7054	9.3751	2.91593	1.21359	2588.7	533267
825	680625	561515625	28.7228	9.3789	2.91645	1.21212	2591.8	534562
826	682276	563559976	28.7402	9.3827	2.91698	1.21065	2595.0	535858
827	683929	565609283	28.7576	9.3865	2.91751	1.20919	2598.1	537157
828	685584	567663552	28.7750	9.3902	2.91803	1.20773	2601.2	538456
829	687241	569722789	28.7924	9.3940	2.91855	1.20627	2604.4	539758
830	688900	571787000	28.8097	9.3978	2.91908	1.20482	2607.5	541061
831	690561	573856191	28.8271	9.4016	2.91960	1.20337	2610.7	542365
832	692224	575930368	28.8444	9.4053	2.92012	1.20192	2613.8	543671
833	693889	578009537	28.8617	9.4091	2.92065	1.20048	2616.9	544979
834	695556	580093704	28.8791	9.4129	2.92117	1.19904	2620.1	546288
835	697225	582182875	28.8964	9.4166	2.92169	1.19760	2623.2	547599
836	698896	584277056	28.9137	9.4204	2.92221	1.19617	2626.4	548912
837	700569	586376253	28.9310	9.4241	2.92273	1.19474	2629.5	550226
838	702244	588480472	28.9482	9.4279	2.92324	1.19332	2632.7	551541
839	703921	590589719	28.9655	9.4316	2.92376	1.19190	2635.8	552858
840	705600	592704000	28.9828	9.4354	2.92428	1.19048	2638.9	554177
841	707281	594823321	29.0000	9.4391	2.92480	1.18906	2642.1	555497
842	708964	596947688	29.0172	9.4429	2.92531	1.18765	2645.2	556819
843	710649	599077107	29.0345	9.4466	2.92583	1.18624	2648.4	558142
844	712336	601211584	29.0517	9.4503	2.92634	1.18483	2651.5	559467
845	714025	603351125	29.0689	9.4541	2.92686	1.18343	2654.6	560794
846	715716	605495736	29.0861	9.4578	2.92737	1.18203	2657.8	562122
847	717409	607645423	29.1033	9.4615	2.92788	1.18064	2660.9	563452
848	719104	609800192	29.1204	9.4652	2.92840	1.17925	2664.1	564783
849	720801	611960049	29.1376	9.4690	2.92891	1.17786	2667.2	566116

FUNCTIONS OF NUMBERS 850 TO 899

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
850	722500	614125000	29.1548	9.4727	2.92942	1.17647	2670.4	567450
851	724201	616295051	29.1719	9.4764	2.92993	1.17509	2673.5	568786
852	725904	618470208	29.1890	9.4801	2.93044	1.17371	2676.6	570124
853	727609	620650477	29.2062	9.4838	2.93095	1.17233	2679.8	571463
854	729316	622835864	29.2233	9.4875	2.93146	1.17096	2682.9	572803
855	731025	625026375	29.2404	9.4912	2.93197	1.16959	2686.1	574146
856	732736	627222016	29.2575	9.4949	2.93247	1.16822	2689.2	575490
857	734449	629422793	29.2746	9.4986	2.93298	1.16686	2692.3	576835
858	736164	631628712	29.2916	9.5023	2.93349	1.16550	2695.5	578182
859	737881	633839779	29.3087	9.5060	2.93399	1.16414	2698.6	579530
860	739600	636056000	29.3258	9.5097	2.93450	1.16279	2701.8	580880
861	741321	638277381	29.3428	9.5134	2.93500	1.16144	2704.9	582232
862	743044	640503928	29.3598	9.5171	2.93551	1.16009	2708.1	583585
863	744769	642735647	29.3769	9.5207	2.93601	1.15875	2711.2	584940
864	746496	644972544	29.3939	9.5244	2.93651	1.15741	2714.3	586297
865	748225	647214625	29.4109	9.5281	2.93702	1.15607	2717.5	587655
866	749956	649461896	29.4279	9.5317	2.93752	1.15473	2720.6	589014
867	751689	651714363	29.4449	9.5354	2.93802	1.15340	2723.8	590375
868	753424	653972032	29.4618	9.5391	2.93852	1.15207	2726.9	591738
869	755161	656234909	29.4788	9.5427	2.93902	1.15075	2730.0	593102
870	756900	658503000	29.4958	9.5464	2.93952	1.14943	2733.2	594468
871	758641	660776311	29.5127	9.5501	2.94002	1.14811	2736.3	595835
872	760384	663054848	29.5296	9.5537	2.94052	1.14679	2739.5	597204
873	762129	665338617	29.5466	9.5574	2.94101	1.14548	2742.6	598575
874	763876	667627624	29.5635	9.5610	2.94151	1.14416	2745.8	599947
875	765625	669921875	29.5804	9.5647	2.94201	1.14286	2748.9	601320
876	767376	672221376	29.5973	9.5683	2.94250	1.14155	2752.0	602696
877	769129	674526133	29.6142	9.5719	2.94300	1.14025	2755.2	604073
878	770884	676836152	29.6311	9.5756	2.94349	1.13895	2758.3	605451
879	772641	679151439	29.6479	9.5792	2.94399	1.13766	2761.5	606831
880	774400	681472000	29.6648	9.5828	2.94448	1.13636	2764.6	608212
881	776161	683797841	29.6816	9.5865	2.94498	1.13507	2767.7	609595
882	777924	686128968	29.6985	9.5901	2.94547	1.13379	2770.9	610980
883	779689	688465387	29.7153	9.5937	2.94596	1.13250	2774.0	612366
884	781456	690807104	29.7321	9.5973	2.94645	1.13122	2777.2	613754
885	783225	693154125	29.7489	9.6010	2.94694	1.12994	2780.3	615143
886	784996	695506456	29.7658	9.6046	2.94743	1.12867	2783.5	616534
887	786769	697864103	29.7825	9.6082	2.94792	1.12740	2786.6	617927
888	788544	700227072	29.7993	9.6118	2.94841	1.12613	2789.7	619321
889	790321	702595369	29.8161	9.6154	2.94890	1.12486	2792.9	620717
890	792100	704969000	29.8329	9.6190	2.94939	1.12360	2796.0	622114
891	793881	707347971	29.8496	9.6226	2.94988	1.12233	2799.2	623513
892	795664	709732288	29.8664	9.6262	2.95036	1.12108	2802.3	624913
893	797449	712121957	29.8831	9.6298	2.95085	1.11982	2805.4	626315
894	799236	714516984	29.8998	9.6334	2.95134	1.11857	2808.6	627718
895	801025	716917375	29.9166	9.6370	2.95182	1.11732	2811.7	629124
896	802816	719323136	29.9333	9.6406	2.95231	1.11607	2814.9	630530
897	804609	721734273	29.9500	9.6442	2.95279	1.11483	2818.0	631938
898	806404	724150792	29.9666	9.6477	2.95328	1.11359	2821.2	633348
899	808201	726572699	29.9833	9.6513	2.95376	1.11235	2824.3	634760

900 TO 949 FUNCTIONS OF NUMBERS

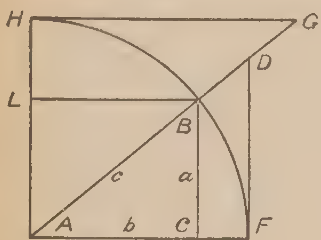
No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter Circum.	No. = Diameter Area
900	810000	729000000	30.0000	9.6549	2.95424	1.11111	2827.4	636173
901	811801	731432701	30.0167	9.6585	2.95472	1.10988	2830.6	637587
902	813604	733870808	30.0333	9.6620	2.95521	1.10865	2833.7	639003
903	815409	736314327	30.0500	9.6656	2.95569	1.10742	2836.9	640421
904	817216	738763264	30.0666	9.6692	2.95617	1.10619	2840.0	641840
905	819025	741217625	30.0832	9.6727	2.95665	1.10497	2843.1	643261
906	820836	743677416	30.0998	9.6763	2.95713	1.10375	2846.3	644683
907	822649	746142643	30.1164	9.6799	2.95761	1.10254	2849.4	646107
908	824464	748613312	30.1330	9.6834	2.95809	1.10132	2852.6	647533
909	826281	751089429	30.1496	9.6870	2.95856	1.10011	2855.7	648960
910	828100	753571000	30.1662	9.6905	2.95904	1.09890	2858.8	650388
911	829921	756058031	30.1828	9.6941	2.95952	1.09769	2862.0	651818
912	831744	758550528	30.1993	9.6976	2.95999	1.09649	2865.1	653250
913	833569	761048497	30.2159	9.7012	2.96047	1.09529	2868.3	654684
914	835396	763551944	30.2324	9.7047	2.96095	1.09409	2871.4	656118
915	837225	766060875	30.2490	9.7082	2.96142	1.09290	2874.6	657555
916	839056	768575296	30.2655	9.7118	2.96190	1.09170	2877.7	658993
917	840889	771095213	30.2820	9.7153	2.96237	1.09051	2880.8	660433
918	842724	773620632	30.2985	9.7188	2.96284	1.08932	2884.0	661874
919	844561	776151559	30.3150	9.7224	2.96332	1.08814	2887.1	663317
920	846400	778688000	30.3315	9.7259	2.96379	1.08696	2890.3	664761
921	848241	781229961	30.3480	9.7294	2.96426	1.08578	2893.4	666207
922	850084	783777448	30.3645	9.7329	2.96473	1.08460	2896.5	667654
923	851929	786330467	30.3809	9.7364	2.96520	1.08342	2899.7	669103
924	853776	788889024	30.3974	9.7400	2.96567	1.08225	2902.8	670554
925	855625	791453125	30.4138	9.7435	2.96614	1.08108	2906.0	672006
926	857476	794022776	30.4302	9.7470	2.96661	1.07991	2909.1	673460
927	859329	796597983	30.4467	9.7505	2.96708	1.07875	2912.3	674915
928	861184	799178752	30.4631	9.7540	2.96755	1.07759	2915.4	676372
929	863041	801765089	30.4795	9.7575	2.96802	1.07643	2918.5	677831
930	864900	804357000	30.4959	9.7610	2.96848	1.07527	2921.7	679291
931	866761	806954491	30.5123	9.7645	2.96895	1.07411	2924.8	680752
932	868624	809557568	30.5287	9.7680	2.96942	1.07296	2928.0	682216
933	870489	812166237	30.5450	9.7715	2.96988	1.07181	2931.1	683680
934	872356	814780504	30.5614	9.7750	2.97035	1.07066	2934.2	685147
935	874225	817400375	30.5778	9.7785	2.97081	1.06952	2937.4	686615
936	876096	820025856	30.5941	9.7819	2.97128	1.06838	2940.5	688084
937	877969	822656953	30.6105	9.7854	2.97174	1.06724	2943.7	689555
938	879844	825293672	30.6268	9.7889	2.97220	1.06610	2946.8	691028
939	881721	827936019	30.6431	9.7924	2.97267	1.06496	2950.0	692502
940	883600	830584000	30.6594	9.7959	2.97313	1.06383	2953.1	693978
941	885481	833237621	30.6757	9.7993	2.97359	1.06270	2956.2	695455
942	887364	835896888	30.6920	9.8028	2.97405	1.06157	2959.4	696934
943	889249	838561807	30.7083	9.8063	2.97451	1.06045	2962.5	698415
944	891136	841232384	30.7246	9.8097	2.97497	1.05932	2965.7	699897
945	893025	843908625	30.7409	9.8132	2.97543	1.05820	2968.8	701380
946	894916	846590536	30.7571	9.8167	2.97589	1.05708	2971.9	702865
947	896809	849278123	30.7734	9.8201	2.97635	1.05597	2975.1	704352
948	898704	851971392	30.7896	9.8236	2.97681	1.05485	2978.2	705840
949	900601	854670349	30.8058	9.8270	2.97727	1.05374	2981.4	707330

FUNCTIONS OF NUMBERS 950 TO 999

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 × Reciprocal	No. = Diameter	
							Circum.	Area
950	902500	857375000	30.8221	9.8305	2.97772	1.05263	2984.5	708822
951	904401	860085351	30.8383	9.8339	2.97818	1.05152	2987.7	710315
952	906304	862801408	30.8545	9.8374	2.97864	1.05042	2990.8	711809
953	908209	865523177	30.8707	9.8408	2.97909	1.04932	2993.9	713306
954	910116	868250664	30.8869	9.8443	2.97955	1.04822	2997.1	714803
955	912025	870983875	30.9031	9.8477	2.98000	1.04712	3000.2	716303
956	913936	873722816	30.9192	9.8511	2.98046	1.04603	3003.4	717804
957	915849	876467493	30.9354	9.8546	2.98091	1.04493	3006.5	719306
958	917764	879217912	30.9516	9.8580	2.98137	1.04384	3009.6	720810
959	919681	881974079	30.9677	9.8614	2.98182	1.04275	3012.8	722316
960	921600	884736000	30.9839	9.8648	2.98227	1.04167	3015.9	723823
961	923521	887503681	31.0000	9.8683	2.98272	1.04058	3019.1	725332
962	925444	890277128	31.0161	9.8717	2.98318	1.03950	3022.2	726842
963	927369	893056347	31.0322	9.8751	2.98363	1.03842	3025.4	728354
964	929296	895841344	31.0483	9.8785	2.98408	1.03734	3028.5	729867
965	931225	898632125	31.0644	9.8819	2.98453	1.03627	3031.6	731382
966	933156	901428696	31.0805	9.8854	2.98498	1.03520	3034.8	732899
967	935089	904231063	31.0966	9.8888	2.98543	1 03413	3037.9	734417
968	937024	907039232	31.1127	9.8922	2.98588	1.03306	3041.1	735937
969	938961	909853209	31.1288	9.8956	2.98632	1.03199	3044.2	737458
970	940900	912673000	31.1448	9.8990	2.98677	1.03093	3047.3	738981
971	942841	915498611	31.1609	9.9024	2.98722	1.02987	3050.5	740506
972	944784	918330048	31.1769	9.9058	2.98767	1.02881	3053.6	742032
973	946729	921167317	31.1929	9.9092	2.98811	1.02775	3056.8	743559
974	948676	924010424	31.2090	9.9126	2.98856	1.02669	3059.9	745088
975	950625	926859375	31.2250	9.9160	2.98900	1.02564	3063.1	746619
976	952576	929714176	31.2410	9.9194	2.98945	1.02459	3066.2	748151
977	954529	932574833	31.2570	9.9227	2.98989	1.02354	3069.3	749685
978	956484	935441352	31.2730	9.9261	2.99034	1.02249	3072.5	751221
979	958441	938313739	31.2890	9 9295	2.99078	1.02145	3075.6	752758
980	960400	941192000	31.3050	9.9329	2.99123	1.02041	3078.8	754296
981	962361	944076141	31.3209	9.9363	2.99167	1.01937	3081.9	755837
982	964324	946966168	31.3369	9.9396	2.99211	1.01833	3085.0	757378
983	966289	949862087	31.3528	9.9430	2.99255	1.01729	3088.2	758922
984	968256	952763904	31.3688	9.9464	2.99300	1.01626	3091.3	760466
985	970225	955671625	31.3847	9.9497	2.99344	1.01523	3094.5	762013
986	972196	958585256	31.4006	9.9531	2.99388	1.01420	3097.6	763561
987	974169	961504803	31.4166	9.9565	2.99432	1.01317	3100.8	765111
988	976144	964430272	31.4325	9.9598	2.99476	1.01215	3103.9	766662
989	978121	967361669	31.4484	9.9632	2.99520	1.01112	3107.0	768214
990	980100	970299000	31.4643	9.9666	2.99564	1.01010	3110.2	769769
991	982081	973242271	31.4802	9.9699	2.99607	1.00908	3113.3	771325
992	984064	976191488	31.4960	9.9733	2.99651	1.00806	3116.5	772882
993	986049	979146657	31.5119	9.9766	2.99695	1.00705	3119.6	774441
994	988036	982107784	31.5278	9.9800	2.99739	1.00604	3122.7	776002
995	990025	985074875	31.5436	9.9833	2.99782	1.00503	3125.9	777564
996	992016	988047936	31.5595	9.9866	2.99826	1.00402	3129.0	779128
997	994009	991026973	31.5753	9.9900	2.99870	1.00301	3132.2	780693
998	996004	994011992	31.5911	9.9933	2.99913	1.00200	3135.3	782260
999	998001	997002999	31.6070	9.9967	2.99957	1.00100	3138.5	783828

TRIGONOMETRIC FORMULAE

TRIGONOMETRIC FUNCTIONS



Radius $AF = 1$

$= \sin^2 A + \cos^2 A = \sin A \operatorname{cosec} A$

$= \cos A \sec A = \tan A \cot A$

Sine $A = \dfrac{\cos A}{\cot A} = \dfrac{1}{\operatorname{cosec} A} = \cos A \tan A = \sqrt{1-\cos^2 A} = BC$

Cosine $A = \dfrac{\sin A}{\tan A} = \dfrac{1}{\sec A} = \sin A \cot A = \sqrt{1-\sin^2 A} = AC$

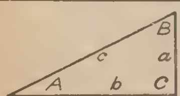
Tangent $A = \dfrac{\sin A}{\cos A} = \dfrac{1}{\cot A} = \sin A \sec A = FD$

Cotangent $A = \dfrac{\cos A}{\sin A} = \dfrac{1}{\tan A} = \cos A \operatorname{cosec} A = HG$

Secant $A = \dfrac{\tan A}{\sin A} = \dfrac{1}{\cos A} = AD$

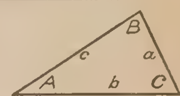
Cosecant $A = \dfrac{\cot A}{\cos A} = \dfrac{1}{\sin A} = AG$

TRIGONOMETRIC SOLUTION OF TRIANGLES



$$a^2 = b^2 + c^2 - 2\,bc \cos A$$
$$b^2 = a^2 + c^2 - 2\,ac \cos B$$
$$c^2 = a^2 + b^2 - 2\,ab \cos C$$

$$s = \frac{a+b+c}{2}$$



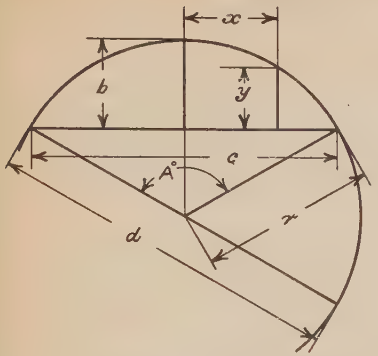
RIGHT ANGLED TRIANGLES

Known	Required A	B	C	a	b	c	Area
a, b	$\tan A = \dfrac{a}{b}$	$\tan B = \dfrac{b}{a}$	$90°$			$\sqrt{a^2+b^2}$	$\dfrac{ab}{2}$
a, c	$\sin A = \dfrac{a}{c}$	$\cos B = \dfrac{a}{c}$	$90°$		$\sqrt{c^2-a^2}$		$\dfrac{a\sqrt{c^2-a^2}}{2}$
A, a		$90° - A$	$90°$		$a \cot A$	$\dfrac{a}{\sin A}$	$\dfrac{a^2 \cot A}{2}$
A, b		$90° - A$	$90°$	$b \tan A$		$\dfrac{b}{\cos A}$	$\dfrac{b^2 \tan A}{2}$
A, c		$90° - A$	$90°$	$c \sin A$	$c \cos A$		$\dfrac{c^2 \sin 2A}{4}$

OBLIQUE ANGLED TRIANGLES

Known	Required A	B	C	b	c	Area
a, b, c	$\cos \frac{1}{2} A = \sqrt{\dfrac{s(s-a)}{bc}}$	$\cos \frac{1}{2} B = \sqrt{\dfrac{s(s-b)}{ac}}$	$\cos \frac{1}{2} C = \sqrt{\dfrac{s(s-c)}{ab}}$			$\sqrt{s(s-a)(s-b)(s-c)}$
a, A, B			$180° - (A+B)$	$\dfrac{a \sin B}{\sin A}$	$\dfrac{a \sin C}{\sin A}$	
a, b, A		$\sin B = \dfrac{b \sin A}{a}$			$\dfrac{b \sin C}{\sin B}$	
a, b, C	$\tan A = \dfrac{a \sin C}{b - a \cos C}$				$\sqrt{a^2+b^2-2ab \cos C}$	$\dfrac{ab \sin C}{2}$

PROPERTIES OF THE CIRCLE



$\pi = 3.14159265359$

Circumference $= 2\,\pi\,r = \pi\,d$

Diameter $=$ Circumference $\times$ 0.31831

Area $= \pi\,r^2$

Diameter of Circle of equal periphery as square
$=$ side of square $\times$ 1.27324

Side of Square of equal periphery as circle
$=$ diameter of circle $\times$ 0.78540

Diameter of Circle circumscribed about square
$=$ side of square $\times$ 1.41421

Side of Square inscribed in a circle
$=$ diameter of circle $\times$ 0.70711

Arc $a = \dfrac{\pi\,r\,A^\circ}{180} = 0.017453\,r\,A^\circ$

Angle $A = \dfrac{180^\circ\,a}{\pi\,r} = 57.29578\,\dfrac{a}{r}$

Radius $r = \dfrac{4\,b^2 + c^2}{8\,b}$

Chord $c = 2\sqrt{2\,br - b^2} = 2\,r\,\sin\dfrac{A^\circ}{2}$

Rise $b = r - \tfrac{1}{2}\sqrt{4\,r^2 - c^2} = \dfrac{c}{2}\tan\dfrac{A^\circ}{4}$

$= 2\,r\,\sin^2\dfrac{A}{4} = r + y - \sqrt{r^2 - x^2}$

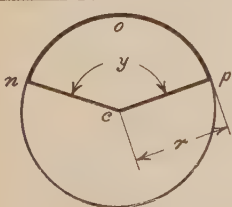
$y = b - r + \sqrt{r^2 - x^2}$

$x = \sqrt{r^2 - (r + y - b)^2}$

$\pi^2 = 9.8696044$, log $= 0.9942997$ | $\dfrac{1}{\pi} = 0.3183099$, log $= \bar{1}.5028501$ | $\sqrt{\dfrac{1}{\pi}} = 0.5641896$, log $= \bar{1}.7514251$

$\pi^3 = 31.0062767$, log $= 1.4914496$ | $\dfrac{1}{\pi^2} = 0.1013212$, log $= \bar{1}.0057003$ | $\dfrac{\pi}{180} = 0.0174533$, log $= \bar{2}.2418774$

$\sqrt{\pi} = 1.7724539$, log $= 0.2485749$ | $\dfrac{1}{\pi^3} = 0.0322515$, log $= \bar{2}.5085500$ | $\dfrac{180}{\pi} = 57.2957795$, log $= 1.7581226$



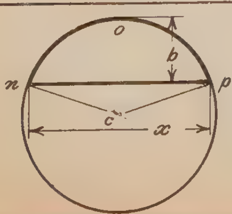
CIRCULAR SECTOR

r = radius of circle $\qquad y$ = angle $ncpo$ in degrees

Area of Sector $ncpo$ $= \tfrac{1}{2}$ (length of arc $nop \times r$)

$=$ Area of Circle $\times \dfrac{y}{360}$

$= 0.0087266 \times r^2 \times y$



CIRCULAR SEGMENT

r = radius of circle $\qquad x$ = chord $\qquad b$ = rise

Area of Segment nop = Area of Sector $ncpo$ − Area of triangle ncp

$= \dfrac{(\text{Length of arc } nop \times r) - x\,(r - b)}{2}$

Area of Segment nsp = Area of Circle − Area of Segment nop

NATURAL SINES AND COSINES

Degrees	Sines							Cosines
	0′	10′	20′	30′	40′	50′	60′	
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01454	0.01745	89
1	0.01745	0.02036	0.02327	0.02618	0.02908	0.03199	0.03490	88
2	0.03490	0.03781	0.04071	0.04362	0.04653	0.04943	0.05234	87
3	0.05234	0.05524	0.05814	0.06105	0.06395	0.06685	0.06976	86
4	0.06976	0.07266	0.07556	0.07846	0.08136	0 08426	0.08716	85
5	0.08716	0.09005	0.09295	0.09585	0.09874	0.10164	0.10453	84
6	0.10453	0.10742	0.11031	0.11320	0.11609	0.11898	0.12187	83
7	0.12187	0.12476	0.12764	0.13053	0.13341	0.13629	0.13917	82
8	0.13917	0.14205	0.14493	0.14781	0.15069	0.15356	0.15643	81
9	0.15643	0.15931	0.16218	0.16505	0.16792	0.17078	0.17365	80
10	0.17365	0.17651	0.17937	0.18224	0 18509	0.18795	0.19081	79
11	0.19081	0.19366	0.19652	0.19937	0.20222	0.20507	0.20791	78
12	0.20791	0.21076	0.21360	0.21644	0.21928	0.22212	0.22495	77
13	0.22495	0.22778	0.23062	0.23345	0.23627	0.23910	0.24192	76
14	0.24192	0.24474	0.24756	0.25038	0.25320	0.25601	0.25882	75
15	0.25882	0.26163	0.26443	0.26724	0.27004	0.27284	0.27564	74
16	0.27564	0.27843	0.28123	0.28402	0.28680	0.28959	0.29237	73
17	0.29237	0.29515	0.29793	0.30071	0.30348	0.30625	0.30902	72
18	0.30902	0.31178	0.31454	0.31730	0.32006	0.32282	0.32557	71
19	0.32557	0.32832	0.33106	0.33381	0.33655	0.33929	0.34202	70
20	0.34202	0.34475	0.34748	0.35021	0.35293	0.35565	0.35837	69
21	0.35837	0.36108	0.36379	0.36650	0.36921	0.37191	0.37461	68
22	0.37461	0.37730	0.37999	0.38268	0.38537	0.38805	0.39073	67
23	0.39073	0.39341	0.39608	0.39875	0.40142	0.40408	0.40674	66
24	0.40674	0.40939	0.41204	0.41469	0.41734	0.41998	0.42262	65
25	0.42262	0.42525	0.42788	0.43051	0.43313	0.43575	0.43837	64
26	0.43837	0.44098	0.44359	0.44620	0.44880	0.45140	0.45399	63
27	0.45399	0.45658	0.45917	0.46175	0.46433	0.46690	0.46947	62
28	0.46947	0.47204	0.47460	0.47716	0.47971	0.48226	0.48481	61
29	0.48481	0.48735	0.48989	0.49242	0.49495	0.49748	0.50000	60
30	0.50000	0.50252	0.50503	0.50754	0.51004	0.51254	0.51504	59
31	0.51504	0.51753	0.52002	0.52250	0.52498	0.52745	0.52992	58
32	0.52992	0.53238	0.53484	0.53730	0.53975	0.54220	0.54464	57
33	0.54464	0.54708	0.54951	0.55194	0.55436	0.55678	0.55919	56
34	0.55919	0.56160	0.56401	0.56641	0.56880	0.57119	0.57358	55
35	0.57358	0.57596	0.57833	0.58070	0.58307	0.58543	0.58779	54
36	0.58779	0.59014	0.59248	0.59482	0.59716	0.59949	0.60182	53
37	0.60182	0.60414	0.60645	0.60876	0.61107	0.61337	0.61566	52
38	0.61566	0.61795	0.62024	0.62251	0.62479	0.62706	0.62932	51
39	0.62932	0.63158	0.63383	0.63608	0.63832	0.64056	0.64279	50
40	0.64279	0.64501	0.64723	0.64945	0.65166	0.65386	0.65606	49
41	0.65606	0.65825	0.66044	0.66262	0.66480	0.66697	0.66913	48
42	0.66913	0.67129	0.67344	0.67559	0.67773	0.67987	0.68200	47
43	0.68200	0.68412	0.68624	0.68835	0.69046	0.69256	0.69466	46
44	0.69466	0.69675	0.69883	0.70091	0.70298	0.70505	0.70711	45
Sines	60′	50′	40′	30′	20′	10′	0′	Degrees
	Cosines							

NATURAL SINES AND COSINES

Degrees	Cosines							Sines
	0′	10′	20′	30′	40′	50′	60′	
0	1.00000	1.00000	0.99998	0.99996	0.99993	0.99989	0.99985	89
1	0.99985	0.99979	0.99973	0.99966	0.99958	0.99949	0.99939	88
2	0.99939	0.99929	0.99917	0.99905	0.99892	0.99878	0.99863	87
3	0.99863	0.99847	0.99831	0.99813	0.99795	0.99776	0.99756	86
4	0.99756	0.99736	0.99714	0.99692	0.99668	0.99644	0.99619	85
5	0.99619	0.99594	0.99567	0.99540	0.99511	0.99482	0.99452	84
6	0.99452	0.99421	0.99390	0.99357	0.99324	0.99290	0.99255	83
7	0.99255	0.99219	0.99182	0.99144	0.99106	0.99067	0.99027	82
8	0.99027	0.98986	0.98944	0.98902	0.98858	0.98814	0.98769	81
9	0.98769	0.98723	0.98676	0.98629	0.98580	0.98531	0.98481	80
10	0.98481	0.98430	0.98378	0.98325	0.98272	0.98218	0.98163	79
11	0.98163	0.98107	0.98050	0.97992	0.97934	0.97875	0.97815	78
12	0.97815	0.97754	0.97692	0.97630	0.97566	0.97502	0.97437	77
13	0.97437	0.97371	0.97304	0.97237	0.97169	0.97100	0.97030	76
14	0.97030	0.96959	0.96887	0.96815	0.96742	0.96667	0.96593	75
15	0.96593	0.96517	0.96440	0.96363	0.96285	0.96206	0.96126	74
16	0.96126	0.96046	0.95964	0.95882	0.95799	0.95715	0.95630	73
17	0.95630	0.95545	0.95459	0.95372	0.95284	0.95195	0.95106	72
18	0.95106	0.95015	0.94924	0.94832	0.94740	0.94646	0.94552	71
19	0.94552	0.94457	0.94361	0.94264	0.94167	0.94068	0.93969	70
20	0.93969	0.93869	0.93769	0.93667	0.93565	0.93462	0.93358	69
21	0.93358	0.93253	0.93148	0.93042	0.92935	0.92827	0.92718	68
22	0.92718	0.92609	0.92499	0.92388	0.92276	0.92164	0.92050	67
23	0.92050	0.91936	0.91822	0.91706	0.91590	0.91472	0.91355	66
24	0.91355	0.91236	0.91116	0.90996	0.90875	0.90753	0.90631	65
25	0.90631	0.90507	0.90383	0.90259	0.90133	0.90007	0.89879	64
26	0.89879	0.89752	0.89623	0.89493	0.89363	0.89232	0.89101	63
27	0.89101	0.88968	0.88835	0.88701	0.88566	0.88431	0.88295	62
28	0.88295	0.88158	0.88020	0.87882	0.87743	0.87603	0.87462	61
29	0.87462	0.87321	0.87178	0.87036	0.86892	0.86748	0.86603	60
30	0.86603	0.86457	0.86310	0.86163	0.86015	0.85866	0.85717	59
31	0.85717	0.85567	0.85416	0.85264	0.85112	0.84959	0.84805	58
32	0.84805	0.84650	0.84495	0.84339	0.84182	0.84025	0.83867	57
33	0.83867	0.83708	0.83549	0.83389	0.83228	0.83066	0.82904	56
34	0.82904	0.82741	0.82577	0.82413	0.82248	0.82082	0.81915	55
35	0.81915	0.81748	0.81580	0.81412	0.81242	0.81072	0.80902	54
36	0.80902	0.80730	0.80558	0.80386	0.80212	0.80038	0.79864	53
37	0.79864	0.79688	0.79512	0.79335	0.79158	0.78980	0.78801	52
38	0.78801	0.78622	0.78442	0.78261	0.78079	0.77897	0.77715	51
39	0.77715	0.77531	0.77347	0.77162	0.76977	0.76791	0.76604	50
40	0.76604	0.76417	0.76229	0.76041	0.75851	0.75661	0.75471	49
41	0.75471	0.75280	0.75088	0.74896	0.74703	0.74509	0.74314	48
42	0.74314	0.74120	0.73924	0.73728	0.73531	0.73333	0.73135	47
43	0.73135	0.72937	0.72737	0.72537	0.72337	0.72136	0.71934	46
44	0.71934	0.71732	0.71529	0.71325	0.71121	0.70916	0.70711	45
Cosines	60′	50′	40′	30′	20′	10′	0′	Degrees
	Sines							

NATURAL TANGENTS AND COTANGENTS

Degrees	Tangents							Cotangents
	0′	10′	20′	30′	40′	50′	60′	
0	0.00000	0.00291	0.00582	0.00873	0.01164	0.01455	0.01746	89
1	0.01746	0.02036	0.02328	0.02619	0.02910	0.03201	0.03492	88
2	0.03492	0.03783	0.04075	0.04366	0.04658	0.04949	0.05241	87
3	0.05241	0.05533	0.05824	0.06116	0.06408	0.06700	0.06993	86
4	0.06993	0.07285	0.07578	0.07870	0.08163	0.08456	0.08749	85
5	0.08749	0.09042	0.09335	0.09629	0.09923	0.10216	0.10510	84
6	0.10510	0.10805	0.11099	0.11394	0.11688	0.11983	0.12278	83
7	0.12278	0.12574	0.12869	0.13165	0.13461	0.13758	0.14054	82
8	0.14054	0.14351	0.14648	0.14945	0.15243	0.15540	0.15838	81
9	0.15838	0.16137	0.16435	0.16734	0.17033	0.17333	0.17633	80
10	0.17633	0.17933	0.18233	0.18534	0.18835	0.19136	0.19438	79
11	0.19438	0.19740	0.20042	0.20345	0.20648	0.20952	0.21256	78
12	0.21256	0.21560	0.21864	0.22169	0.22475	0.22781	0.23087	77
13	0.23087	0.23393	0.23700	0.24008	0.24316	0.24624	0.24933	76
14	0.24933	0.25242	0.25552	0.25862	0.26172	0.26483	0.26795	75
15	0.26795	0.27107	0.27419	0.27732	0.28046	0.28360	0.28675	74
16	0.28675	0.28990	0.29305	0.29621	0.29938	0.30255	0.30573	73
17	0.30573	0.30891	0.31210	0.31530	0.31850	0.32171	0.32492	72
18	0.32492	0.32814	0.33136	0.33460	0.33783	0.34108	0.34433	71
19	0.34433	0.34758	0.35085	0.35412	0.35740	0.36068	0.36397	70
20	0.36397	0.36727	0.37057	0.37388	0.37720	0.38053	0.38386	69
21	0.38386	0.38721	0.39055	0.39391	0.39727	0.40065	0.40403	68
22	0.40403	0.40741	0.41081	0.41421	0.41763	0.42105	0.42447	67
23	0.42447	0.42791	0.43136	0.43481	0.43828	0.44175	0.44523	66
24	0.44523	0.44872	0.45222	0.45573	0.45924	0.46277	0.46631	65
25	0.46631	0.46985	0.47341	0.47698	0.48055	0.48414	0.48773	64
26	0.48773	0.49134	0.49495	0.49858	0.50222	0.50587	0.50953	63
27	0.50953	0.51320	0.51688	0.52057	0.52427	0.52798	0.53171	62
28	0.53171	0.53545	0.53920	0.54296	0.54674	0.55051	0.55431	61
29	0.55431	0.55812	0.56194	0.56577	0.56962	0.57348	0.57735	60
30	0.57735	0.58124	0.58513	0.58905	0.59297	0.59691	0.60086	59
31	0.60086	0.60483	0.60881	0.61280	0.61681	0.62083	0.62487	58
32	0.62487	0.62892	0.63299	0.63707	0.64117	0.64528	0.64941	57
33	0.64941	0.65355	0.65771	0.66189	0.66608	0.67028	0.67451	56
34	0.67451	0.67875	0.68301	0.68728	0.69157	0.69588	0.70021	55
35	0.70021	0.70455	0.70891	0.71329	0.71769	0.72211	0.72654	54
36	0.72654	0.73100	0.73547	0.73996	0.74447	0.74900	0.75355	53
37	0.75355	0.75812	0.76272	0.76733	0.77196	0.77661	0.78129	52
38	0.78129	0.78598	0.79070	0.79544	0.80020	0.80498	0.80978	51
39	0.80978	0.81461	0.81946	0.82434	0.82923	0.83415	0.83910	50
40	0.83910	0.84407	0.84906	0.85408	0.85912	0.86419	0.86929	49
41	0.86929	0.87441	0.87955	0.88473	0.88992	0.89515	0.90040	48
42	0.90040	0.90569	0.91099	0.91633	0.92170	0.92709	0.93252	47
43	0.93252	0.93797	0.94345	0.94896	0.95451	0.96008	0.96569	46
44	0.96569	0.97133	0.97700	0.98270	0.98843	0.99420	1.00000	45
Tangents	60′	50′	40′	30′	20′	10′	0′	Degrees
	Cotangents							

NATURAL TANGENTS AND COTANGENTS

Degrees	Cotangents							Tangents
	0′	10′	20′	30′	40′	50′	60′	
0	∞	343.77371	171.88540	114.58865	85.93979	68.75009	57.28996	89
1	57.28996	49.10388	42.96408	38.18846	34.36777	31.24158	28.63625	88
2	28.63625	26.43160	24.54176	22.90377	21.47040	20.20555	19.08114	87
3	19.08114	18.07498	17.16934	16.34986	15.60478	14.92442	14.30067	86
4	14.30067	13.72674	13.19688	12.70621	12.25051	11.82617	11.43005	85
5	11.43005	11.05943	10.71191	10.38540	10.07803	9.78817	9.51436	84
6	9.51436	9.25530	9.00983	8.77689	8.55555	8.34496	8.14435	83
7	8.14435	7.95302	7.77035	7.59575	7.42871	7.26873	7.11537	82
8	7.11537	6.96823	6.82694	6.69116	6.56055	6.43484	6.31375	81
9	6.31375	6.19703	6.08444	5.97576	5.87080	5.76937	5.67128	80
10	5.67128	5.57638	5.48451	5.39552	5.30928	5.22566	5.14455	79
11	5.14455	5.06584	4.98940	4.91516	4.84300	4.77286	4.70463	78
12	4.70463	4.63825	4.57363	4.51071	4.44942	4.38969	4.33148	77
13	4.33148	4.27471	4.21933	4.16530	4.11256	4.06107	4.01078	76
14	4.01078	3.96165	3.91364	3.86671	3.82083	3.77595	3.73205	75
15	3.73205	3.68909	3.64705	3.60588	3.56557	3.52609	3.48741	74
16	3.48741	3.44951	3.41236	3.37594	3.34023	3.30521	3.27085	73
17	3.27085	3.23714	3.20406	3.17159	3.13972	3.10842	3.07768	72
18	3.07768	3.04749	3.01783	2.98869	2.96004	2.93189	2.90421	71
19	2.90421	2.87700	2.85023	2.82391	2.79802	2.77254	2.74748	70
20	2.74748	2.72281	2.69853	2.67462	2.65109	2.62791	2.60509	69
21	2.60509	2.58261	2.56046	2.53865	2.51715	2.49597	2.47509	68
22	2.47509	2.45451	2.43422	2.41421	2.39449	2.37504	2.35585	67
23	2.35585	2.33693	2.31826	2.29984	2.28167	2.26374	2.24604	66
24	2.24604	2.22857	2.21132	2.19430	2.17749	2.16090	2.14451	65
25	2.14451	2.12832	2.11233	2.09654	2.08094	2.06553	2.05030	64
26	2.05030	2.03526	2.02039	2.00569	1.99116	1.97680	1.96261	63
27	1.96261	1.94858	1.93470	1.92098	1.90741	1.89400	1.88073	62
28	1.88073	1.86760	1.85462	1.84177	1.82907	1.81649	1.80405	61
29	1.80405	1.79174	1.77955	1.76749	1.75556	1.74375	1.73205	60
30	1.73205	1.72047	1.70901	1.69766	1.68643	1.67530	1.66428	59
31	1.66428	1.65337	1.64256	1.63185	1.62125	1.61074	1.60033	58
32	1.60033	1.59002	1.57981	1.56969	1.55966	1.54972	1.53987	57
33	1.53987	1.53010	1.52043	1.51084	1.50133	1.49190	1.48256	56
34	1.48256	1.47330	1.46411	1.45501	1.44598	1.43703	1.42815	55
35	1.42815	1.41934	1.41061	1.40195	1.39336	1.38484	1.37638	54
36	1.37638	1.36800	1.35968	1.35142	1.34323	1.33511	1.32704	53
37	1.32704	1.31904	1.31110	1.30323	1.29541	1.28764	1.27994	52
38	1.27994	1.27230	1.26471	1.25717	1.24969	1.24227	1.23490	51
39	1.23490	1.22758	1.22031	1.21310	1.20593	1.19882	1.19175	50
40	1.19175	1.18474	1.17777	1.17085	1.16398	1.15715	1.15037	49
41	1.15037	1.14363	1.13694	1.13029	1.12369	1.11713	1.11061	48
42	1.11061	1.10414	1.09770	1.09131	1.08496	1.07864	1.07237	47
43	1.07237	1.06613	1.05994	1.05378	1.04766	1.04158	1.03553	46
44	1.03553	1.02952	1.02355	1.01761	1.01170	1.00583	1.00000	45
Cotangents	60′	50′	40′	30′	20′	10′	0′	Degrees
	Tangents							

NATURAL SECANTS AND COSECANTS

Degrees	Secants							Cosecants
	0′	10′	20′	30′	40′	50′	60′	
0	1.00000	1.00000	1.00002	1.00004	1.00007	1.00011	1.00015	89
1	1.00015	1.00021	1.00027	1.00034	1.00042	1.00051	1.00061	88
2	1.00061	1.00072	1.00083	1.00095	1.00108	1.00122	1.00137	87
3	1.00137	1.00153	1.00169	1.00187	1.00205	1.00224	1.00244	86
4	1.00244	1.00265	1.00287	1.00309	1.00333	1.00357	1.00382	85
5	1.00382	1.00408	1.00435	1.00463	1.00491	1.00521	1.00551	84
6	1.00551	1.00582	1.00614	1.00647	1.00681	1.00715	1.00751	83
7	1.00751	1.00787	1.00825	1.00863	1.00902	1.00942	1.00983	82
8	1.00983	1.01024	1.01067	1.01111	1.01155	1.01200	1.01247	81
9	1.01247	1.01294	1.01342	1.01391	1.01440	1.01491	1.01543	80
10	1.01543	1.01595	1.01649	1.01703	1.01758	1.01815	1.01872	79
11	1.01872	1.01930	1.01989	1.02049	1.02110	1.02171	1.02234	78
12	1.02234	1.02298	1.02362	1.02428	1.02494	1.02562	1.02630	77
13	1.02630	1.02700	1.02770	1.02842	1.02914	1.02987	1.03061	76
14	1.03061	1.03137	1.03213	1.03290	1.03368	1.03447	1.03528	75
15	1.03528	1.03609	1.03691	1.03774	1.03858	1.03944	1.04030	74
16	1.04030	1.04117	1.04206	1.04295	1.04385	1.04477	1.04569	73
17	1.04569	1.04663	1.04757	1.04853	1.04950	1.05047	1.05146	72
18	1.05146	1.05246	1.05347	1.05449	1.05552	1.05657	1.05762	71
19	1.05762	1.05869	1.05976	1.06085	1.06195	1.06306	1.06418	70
20	1.06418	1.06531	1.06645	1.06761	1.06878	1.06995	1.07115	69
21	1.07115	1.07235	1.07356	1.07479	1.07602	1.07727	1.07853	68
22	1.07853	1.07981	1.08109	1.08239	1.08370	1.08503	1.08636	67
23	1.08636	1.08771	1.08907	1.09044	1.09183	1.09323	1.09464	66
24	1.09464	1.09606	1.09750	1.09895	1.10041	1.10189	1.10338	65
25	1.10338	1.10488	1.10640	1.10793	1.10947	1.11103	1.11260	64
26	1.11260	1.11419	1.11579	1.11740	1.11903	1.12067	1.12233	63
27	1.12233	1.12400	1.12568	1.12738	1.12910	1.13083	1.13257	62
28	1.13257	1.13433	1.13610	1.13789	1.13970	1.14152	1.14335	61
29	1.14335	1.14521	1.14707	1.14896	1.15085	1.15277	1 15470	60
30	1.15470	1.15665	1.15861	1.16059	1.16259	1.16460	1 16663	59
31	1.16663	1.16868	1.17075	1.17283	1.17493	1.17704	1.17918	58
32	1.17918	1.18133	1.18350	1.18569	1.18790	1.19012	1.19236	57
33	1.19236	1.19463	1.19691	1.19920	1.20152	1.20386	1.20622	56
34	1.20622	1.20859	1.21099	1.21341	1.21584	1.21830	1.22077	55
35	1.22077	1.22327	1.22579	1.22833	1.23089	1.23347	1.23607	54
36	1.23607	1.23869	1.24134	1.24400	1.24669	1.24940	1.25214	53
37	1.25214	1.25489	1.25767	1.26047	1.26330	1.26615	1.26902	52
38	1.26902	1.27191	1.27483	1.27778	1.28075	1.28374	1.28676	51
39	1.28676	1.28980	1.29287	1.29597	1.29909	1.30223	1.30541	50
40	1.30541	1.30861	1.31183	1.31509	1.31837	1.32168	1.32501	49
41	1.32501	1.32838	1.33177	1.33519	1.33864	1.34212	1.34563	48
42	1.34563	1.34917	1.35274	1.35634	1.35997	1.36363	1.36733	47
43	1.36733	1.37105	1.37481	1.37860	1.38242	1.38628	1.39016	46
44	1.39016	1.39409	1.39804	1.40203	1.40606	1.41012	1.41421	45
Secants	60′	50′	40′	30′	20′	10′	0′	Degrees
	Cosecants							

NATURAL SECANTS AND COSECANTS

Degrees	Cosecants							Secants
	0′	10′	20′	30′	40′	50′	60′	
0	∞	343.77516	171.88831	114.59301	85.94561	68.75736	57.29869	89
1	57.29869	49.11406	42.97571	38.20155	34.38232	31.25758	28.65371	88
2	28.65371	26.45051	24.56212	22.92559	21.49368	20.23028	19.10732	87
3	19.10732	18.10262	17.19843	16.38041	15.63679	14.95788	14.33559	86
4	14.33559	13.76312	13.23472	12.74550	12.29125	11.86837	11.47371	85
5	11.47371	11.10455	10.75849	10.43343	10.12752	9.83912	9.56677	84
6	9.56677	9.30917	9.06515	8.83367	8.61379	8.40466	8.20551	83
7	8.20551	8.01565	7.83443	7.66130	7.49571	7.33719	7.18530	82
8	7.18530	7.03962	6.89979	6.76547	6.63633	6.51208	6.39245	81
9	6.39245	6.27719	6.16607	6.05886	5.95536	5.85539	5.75877	80
10	5.75877	5.66533	5.57493	5.48740	5.40263	5.32049	5.24084	79
11	5.24084	5.16359	5.08863	5.01585	4.94517	4.87649	4.80973	78
12	4.80973	4.74482	4.68167	4.62023	4.56041	4.50216	4.44541	77
13	4.44541	4.39012	4.33622	4.28366	4.23239	4.18238	4.13357	76
14	4.13357	4.08591	4.03938	3.99393	3.94952	3.90613	3.86370	75
15	3.86370	3.82223	3.78166	3.74198	3.70315	3.66515	3.62796	74
16	3.62796	3.59154	3.55587	3.52094	3.48671	3.45317	3.42030	73
17	3.42030	3.38808	3.35649	3.32551	3.29512	3.26531	3.23607	72
18	3.23607	3.20737	3.17920	3.15155	3.12440	3.09774	3.07155	71
19	3.07155	3.04584	3.02057	2.99574	2.97135	2.94737	2.92380	70
20	2.92380	2.90063	2.87785	2.85545	2.83342	2.81175	2.79043	69
21	2.79043	2.76945	2.74881	2.72850	2.70851	2.68884	2.66947	68
22	2.66947	2.65040	2.63162	2.61313	2.59491	2.57698	2.55930	67
23	2.55930	2.54190	2.52474	2.50784	2.49119	2.47477	2.45859	66
24	2.45859	2.44264	2.42692	2.41142	2.39614	2.38107	2.36620	65
25	2.36620	2.35154	2.33708	2.32282	2.30875	2.29487	2.28117	64
26	2.28117	2.26766	2.25432	2.24116	2.22817	2.21535	2.20269	63
27	2.20269	2.19019	2.17786	2.16568	2.15366	2.14178	2.13005	62
28	2.13005	2.11847	2.10704	2.09574	2.08458	2.07356	2.06267	61
29	2.06267	2.05191	2.04128	2.03077	2.02039	2.01014	2.00000	60
30	2.00000	1.98998	1.98008	1.97029	1.96062	1.95106	1.94160	59
31	1.94160	1.93226	1.92302	1.91388	1.90485	1.89591	1.88709	58
32	1.88708	1.87834	1.86970	1.86116	1.85271	1.84435	1.83608	57
33	1.83608	1.82790	1.81981	1.81180	1.80388	1.79604	1.78829	56
34	1.78829	1.78062	1.77303	1.76552	1.75808	1.75073	1.74345	55
35	1.74345	1.73624	1.72911	1.72205	1.71506	1.70815	1.70130	54
36	1.70130	1.69452	1.68782	1.68117	1.67460	1.66809	1.66164	53
37	1.66164	1.65526	1.64894	1.64268	1.63648	1.63035	1.62427	52
38	1.62427	1.61825	1.61229	1.60639	1.60054	1.59475	1.58902	51
39	1.58902	1.58333	1.57771	1.57213	1.56661	1.56114	1.55572	50
40	1.55572	1.55036	1.54504	1.53977	1.53455	1.52938	1.52425	49
41	1.52425	1.51918	1.51415	1.50916	1.50422	1.49933	1.49448	48
42	1.49448	1.48967	1.48491	1.48019	1.47551	1.47087	1.46628	47
43	1.46628	1.46173	1.45721	1.45274	1.44831	1.44391	1.43956	46
44	1.43956	1.43524	1.43096	1.42672	1.42251	1.41835	1.41421	45
Cosecants	60′	50′	40′	30′	20′	10′	0′	Degrees
	Secants							

DECIMALS OF AN INCH

FOR EACH 1/64TH.

Fractions	Decimals	Fractions	Decimals
1/64	0.015625	33/64	0.515625
1/32	0.03125	17/32	0.53125
3/64	0.046875	35/64	0.546875
1/16	0.0625	9/16	0.5625
5/64	0.078125	37/64	0.578125
3/32	0.09375	19/32	0.59375
7/64	0.109375	39/64	0.609375
1/8	0.125	5/8	0.625
9/64	0.140625	41/64	0.640625
5/32	0.15625	21/32	0.65625
11/64	0.171875	43/64	0.671875
3/16	0.1875	11/16	0.6875
13/64	0.203125	45/64	0.703125
7/32	0.21875	23/32	0.71875
15/64	0.234375	47/64	0.734375
1/4	0.250	3/4	0.750
17/64	0.265625	49/64	0.765625
9/32	0.28125	25/32	0.78125
19/64	0.296875	51/64	0.796875
5/16	0.3125	13/16	0.8125
21/64	0.328125	53/64	0.828125
11/32	0.34375	27/32	0.84375
23/64	0.359375	55/64	0.859375
3/8	0.375	7/8	0.875
25/64	0.390625	57/64	0.890625
13/32	0.40625	29/32	0.90625
27/64	0.421875	59/64	0.921875
7/16	0.4375	15/16	0.9375
29/64	0.453125	61/64	0.953125
15/32	0.46875	31/32	0.96875
31/64	0.484375	63/64	0.984375
1/2	0.500	1″	1.000

DECIMALS OF A FOOT

FOR EACH 1/16 OF AN INCH FROM 1/16 TO 12 INCHES

Fraction	Decimal	Fraction	Decimal	Fraction	Decimal	Fraction	Decimal
1/16	0.0052	3 1/16	0.2552	6 1/16	0.5052	9 1/16	0.7552
1/8	0.0104	3 1/8	0.2604	6 1/8	0.5104	9 1/8	0.7604
3/16	0.0156	3 3/16	0.2656	6 3/16	0.5156	9 3/16	0.7656
1/4	0.0208	3 1/4	0.2708	6 1/4	0.5208	9 1/4	0.7708
5/16	0.0260	3 5/16	0.2760	6 5/16	0.5260	9 5/16	0.7760
3/8	0.0313	3 3/8	0.2813	6 3/8	0.5313	9 3/8	0.7813
7/16	0.0365	3 7/16	0.2865	6 7/16	0.5365	9 7/16	0.7865
1/2	0.0417	3 1/2	0.2917	6 1/2	0.5417	9 1/2	0.7917
9/16	0.0469	3 9/16	0.2969	6 9/16	0.5469	9 9/16	0.7969
5/8	0.0521	3 5/8	0.3021	6 5/8	0.5521	9 5/8	0.8021
11/16	0.0573	3 11/16	0.3073	6 11/16	0.5573	9 11/16	0.8073
3/4	0.0625	3 3/4	0.3125	6 3/4	0.5625	9 3/4	0.8125
13/16	0.0677	3 13/16	0.3177	6 13/16	0.5677	9 13/16	0.8177
7/8	0.0729	3 7/8	0.3229	6 7/8	0.5729	9 7/8	0.8229
15/16	0.0781	3 15/16	0.3281	6 15/16	0.5781	9 15/16	0.8281
1	0.0833	4	0.3333	7	0.5833	10	0.8333
1 1/16	0.0885	4 1/16	0.3385	7 1/16	0.5885	10 1/16	0.8385
1 1/8	0.0938	4 1/8	0.3438	7 1/8	0.5938	10 1/8	0.8438
1 3/16	0.0990	4 3/16	0.3490	7 3/16	0.5990	10 3/16	0.8490
1 1/4	0.1042	4 1/4	0.3542	7 1/4	0.6042	10 1/4	0.8542
1 5/16	0.1094	4 5/16	0.3594	7 5/16	0.6094	10 5/16	0.8594
1 3/8	0.1146	4 3/8	0.3646	7 3/8	0.6146	10 3/8	0.8646
1 7/16	0.1198	4 7/16	0.3698	7 7/16	0.6198	10 7/16	0.8698
1 1/2	0.1250	4 1/2	0.3750	7 1/2	0.6250	10 1/2	0.8750
1 9/16	0.1302	4 9/16	0.3802	7 9/16	0.6302	10 9/16	0.8802
1 5/8	0.1354	4 5/8	0.3854	7 5/8	0.6354	10 5/8	0.8854
1 11/16	0.1406	4 11/16	0.3906	7 11/16	0.6406	10 11/16	0.8906
1 3/4	0.1458	4 3/4	0.3958	7 3/4	0.6458	10 3/4	0.8958
1 13/16	0.1510	4 13/16	0.4010	7 13/16	0.6510	10 13/16	0.9010
1 7/8	0.1563	4 7/8	0.4063	7 7/8	0.6563	10 7/8	0.9063
1 15/16	0.1615	4 15/16	0.4115	7 15/16	0.6615	10 15/16	0.9115
2	0.1667	5	0.4167	8	0.6667	11	0.9167
2 1/16	0.1719	5 1/16	0.4219	8 1/16	0.6719	11 1/16	0.9219
2 1/8	0.1771	5 1/8	0.4271	8 1/8	0.6771	11 1/8	0.9271
2 3/16	0.1823	5 3/16	0.4323	8 3/16	0.6823	11 3/16	0.9323
2 1/4	0.1875	5 1/4	0.4375	8 1/4	0.6875	11 1/4	0.9375
2 5/16	0.1927	5 5/16	0.4427	8 5/16	0.6927	11 5/16	0.9427
2 3/8	0.1979	5 3/8	0.4479	8 3/8	0.6979	11 3/8	0.9479
2 7/16	0.2031	5 7/16	0.4531	8 7/16	0.7031	11 7/16	0.9531
2 1/2	0.2083	5 1/2	0.4583	8 1/2	0.7083	11 1/2	0.9583
2 9/16	0.2135	5 9/16	0.4635	8 9/16	0.7135	11 9/16	0.9635
2 5/8	0.2188	5 5/8	0.4688	8 5/8	0.7188	11 5/8	0.9688
2 11/16	0.2240	5 11/16	0.4740	8 11/16	0.7240	11 11/16	0.9740
2 3/4	0.2292	5 3/4	0.4792	8 3/4	0.7292	11 3/4	0.9792
2 13/16	0.2344	5 13/16	0.4844	8 13/16	0.7344	11 13/16	0.9844
2 7/8	0.2396	5 7/8	0.4896	8 7/8	0.7396	11 7/8	0.9896
2 15/16	0.2448	5 15/16	0.4948	8 15/16	0.7448	11 15/16	0.9948
3	0.2500	6	0.5000	9	0.7500	12	1.0000

LENGTH OF CIRCULAR ARCS FOR THE RADIUS 1

DEGREES						MINUTES		SECONDS	
0°	0.000 0000	60°	1.047 1976	120°	2.094 3951	0′	0.000 0000	0″	0.000 0000
1	0.017 4533	61	1.064 6508	121	2.111 8484	1	0.000 2909	1	0.000 0048
2	0.034 9066	62	1.082 1041	122	2.129 3017	2	0.000 5818	2	0.000 0097
3	0.052 3599	63	1.099 5574	123	2.146 7550	3	0.000 8727	3	0.000 0145
4	0.069 8132	64	1.117 0107	124	2.164 2083	4	0.001 1636	4	0.000 0194
5	0.087 2665	65	1.134 4640	125	2.181 6616	5	0.001 4544	5	0.000 0242
6	0.104 7198	66	1.151 9173	126	2.199 1149	6	0.001 7453	6	0.000 0291
7	0.122 1730	67	1.169 3706	127	2.216 5682	7	0.002 0362	7	0.000 0339
8	0.139 6263	68	1.186 8239	128	2.234 0214	8	0.002 3271	8	0.000 0388
9	0.157 0796	69	1.204 2772	129	2.251 4747	9	0.002 6180	9	0.000 0436
10	0.174 5329	70	1.221 7305	130	2.268 9280	10	0.002 9089	10	0.000 0485
11	0.191 9862	71	1.239 1838	131	2.286 3813	11	0.003 1998	11	0.000 0533
12	0.209 4395	72	1.256 6371	132	2.303 8346	12	0.003 4907	12	0.000 0582
13	0 226 8928	73	1.274 0904	133	2.321 2879	13	0.003 7815	13	0.000 0630
14	0.244 3461	74	1.291 5436	134	2.338 7412	14	0.004 0724	14	0.000 0679
15	0.261 7994	75	1.308 9969	135	2.356 1945	15	0.004 3633	15	0.000 0727
16	0.279 2527	76	1.326 4502	136	2.373 6478	16	0.004 6542	16	0.000 0776
17	0.296 7060	77	1.343 9035	137	2.391 1011	17	0.004 9451	17	0.000 0824
18	0.314 1593	78	1.361 3568	138	2.408 5544	18	0.005 2360	18	0.000 0873
19	0.331 6126	79	1.378 8101	139	2.426 0077	19	0.005 5269	19	0.000 0921
20	0.349 0659	80	1.396 2634	140	2.443 4610	20	0.005 8178	20	0.000 0970
21	0.366 5191	81	1.413 7167	141	2.460 9142	21	0.006 1087	21	0.000 1018
22	0.383 9724	82	1.431 1700	142	2.478 3675	22	0.006 3995	22	0.000 1067
23	0.401 4257	83	1.448 6233	143	2.495 8208	23	0.006 6904	23	0.000 1115
24	0.418 8790	84	1.466 0766	144	2.513 2741	24	0.006 9813	24	0.000 1164
25	0.436 3323	85	1.483 5299	145	2.530 7274	25	0.007 2722	25	0.000 1212
26	0.453 7856	86	1.500 9832	146	2.548 1807	26	0.007 5631	26	0.000 1261
27	0.471 2389	87	1.518 4364	147	2.565 6340	27	0.007 8540	27	0.000 1309
28	0.488 6922	88	1.535 8897	148	2.583 0873	28	0.008 1449	28	0.000 1357
29	0.506 1455	89	1.553 3430	149	2.600 5406	29	0.008 4358	29	0.000 1406
30	0.523 5988	90	1.570 7963	150	2.617 9939	30	0.008 7266	30	0.000 1454
31	0.541 0521	91	1.588 2496	151	2.635 4472	31	0.009 0175	31	0.000 1503
32	0.558 5054	92	1.605 7029	152	2.652 9005	32	0.009 3084	32	0.000 1551
33	0.575 9587	93	1.623 1562	153	2.670 3538	33	0.009 5993	33	0.000 1600
34	0.593 4119	94	1.640 6095	154	2.687 8070	34	0.009 8902	34	0.000 1648
35	0.610 8652	95	1.658 0628	155	2.705 2603	35	0.010 1811	35	0.000 1697
36	0.628 3185	96	1.675 5161	156	2.722 7136	36	0.010 4720	36	0.000 1745
37	0.645 7718	97	1.692 9694	157	2.740 1669	37	0.010 7629	37	0.000 1794
38	0.663 2251	98	1.710 4227	158	2.757 6202	38	0.011 0538	38	0.000 1842
39	0.680 6784	99	1.727 8760	159	2.775 0735	39	0.011 3446	39	0.000 1891
40	0.698 1317	100	1.745 3293	160	2.792 5268	40	0.011 6355	40	0.000 1939
41	0.715 5850	101	1.762 7825	161	2.809 9801	41	0.011 9264	41	0.000 1988
42	0.733 0383	102	1.780 2358	162	2.827 4334	42	0.012 2173	42	0.000 2036
43	0.750 4916	103	1.797 6891	163	2.844 8867	43	0.012 5082	43	0.000 2085
44	0.767 9449	104	1.815 1424	164	2.862 3400	44	0 012 7991	44	0.000 2133
45	0.785 3982	105	1.832 5957	165	2.879 7933	45	0.013 0900	45	0.000 2182
46	0.802 8515	106	1.850 0490	166	2.897 2466	46	0.013 3809	46	0.000 2230
47	0.820 3047	107	1.867 5023	167	2.914 6999	47	0.013 6717	47	0.000 2279
48	0.837 7580	108	1.884 9556	168	2.932 1531	48	0.013 9626	48	0.000 2327
49	0.855 2113	109	1.902 4089	169	2.949 6064	49	0.014 2535	49	0.000 2376
50	0.872 6646	110	1.919 8622	170	2.967 0597	50	0.014 5444	50	0.000 2424
51	0.890 1179	111	1.937 3155	171	2.984 5130	51	0.014 8353	51	0.000 2473
52	0.907 5712	112	1.954 7688	172	3.001 9663	52	0 015 1262	52	0.000 2521
53	0.925 0245	113	1.972 2221	173	3.019 4196	53	0.015 4171	53	0.000 2570
54	0.942 4778	114	1.989 6753	174	3.036 8729	54	0.015 7080	54	0.000 2618
55	0.959 9311	115	2.007 1286	175	3.054 3262	55	0.015 9989	55	0.000 2666
56	0.977 3844	116	2.024 5819	176	3.071 7795	56	0.016 2897	56	0.000 2715
57	0.994 8377	117	2.042 0352	177	3.089 2328	57	0.016 5806	57	0.000 2763
58	1.012 2910	118	2.059 4885	178	3.106 6861	58	0.016 8715	58	0.000 2812
59	1.029 7443	119	2.076 9418	179	3.124 1394	59	0.017 1624	59	0.000 2860
60	1.047 1976	120	2.094 3951	180	3.141 5927	60	0.017 4533	60	0.000 2909

By the use of the above table, the length of any arc may be found if the length of the radius and the angle of the segment be known.

Example:— Required the length of arc of segment of 32° 15′ 27″ with radius of 24 feet 3 inches.

From table. Length of arc (Radius 1) for 32° = .5585054
15′ = .0043633
27″ = .0001309

5629996

.5629996 × 24.25 (length of radius) = 13.65′ = Ans.

Part III

Building Materials

Strength of Materials

Specific Gravities

Properties of
American Standard Yard Lumber and Timber

Safe Loads for Timber Columns

Unit Stresses for Structural Lumber

Contents of Storage Warehouses

STRENGTH OF MATERIALS

STRESS IN KIPS PER SQUARE INCH

Metals and Alloys	Tension, Ultimate	Elastic Limit	Compression, Ultimate	Bending, Ultimate	Shearing, Ultimate	Modulus of Elasticity, Pounds	Elongation, %
Aluminum, cast	15	6.5	12		12	11000000	
" bars, sheets	24-28	12-14					
" wire, hard	30-65	16-30					
" " annealed	20-35	14					
" 2—7% Ni, Cu, Fe, etc	40-50	25					
Aluminum Bronze, 5% to 7½% Al	75	40	120				
" " 10% Al	85-100	60					
Brass, 17% Zn	32.6	8.2		23.2			26.7
" 23% "		7.6	42	22.3			35.8
" 30% "	28.1	8.6		26.9			20.7
" 39% "	41.1	17.4	75	39			20.7
" 50% "	31	17.9	117	33.5			5.0
" cast, common	18-24	6	30	20	36	9000000	
" wire, hard	80						
" " annealed	50	16				14000000	
Bronze 8% Sn	28.5	19	42	43.7		10000000	5.5
" 13% "	29.4	20	53	34.5			3.3
" 20% "	33		78	56.7			0.04
" 24% "	22	22	114	32			0
" 30% "	5.6	5.6	147	12.1			0
" gun metal, 9 Cu, 1 Sn	25-55	10		52		10000000	
" Manganese, cast } 10% Sn	60	30	125				
" " rolled } 2% Mn	100	80					
" Phosphorus, cast } 9% Sn	50	24					
" " wire } 1% P	100						
" Silicon, cast, 3% Si	55						
" " " 5% Si	75						
" " wire	108						
" Tobin, cast } 38% Zn	66						
" " rolled } 1½% Sn	80	40				4500000	
" " cold rolled } ⅓% Pb	100						
Copper, cast	25	6	40	22	30	10000000	
" plates, rods, bolts	32-35	10	32				
" wire, hard	55-65					18000000	
" wire, annealed	36	10				15000000	
Delta Metal, cast } 55—60% Cu	45						
" " plates } 38—40% Zn	68						
" " bars } 2— 4% Fe	85						
" " wire } 1— 2% Sn	100						
German Silver, 25% Zn, 20% Ni							
Gold, cast	20	4				8000000	
" wire	30						
" copper, 5 Au, 1 Cu	50						
Iron, cast, common	15-18	6	80	30	18-20	12000000	
" " gray	18-24			25-33			
" " malleable	27-35	15-20	46	30	40		
Iron, wrought, shapes	48	26	tensile	tensile	⅚ tens.	28000000	
" " bars	50	27	tensile	tensile	⅚ tens.	28000000	
" " wire, unannealed	80					15000000	
" " " annealed	60	27				25000000	
Lead, cast	1.8					1000000	
" pipe, wire	2.2-2.5					1000000	
" rolled, sheets	3.3					720000	
Platinum, wire, unannealed	53						
" " annealed	32						
Silver, cast	40						
Steel, boiler plates*, fire box	55-65	½ tens.	tensile	tensile	¾ tens.	29000000	27.3-23.0
" " " flange plates	52-62	½ tens.	tensile	tensile	¾ tens.	29000000	28.8-24.2
" castings*, soft	60	27	tensile	tensile	¾ tens.	29000000	22.0
" " medium	70	31.5	tensile	tensile	¾ tens.	29000000	18.0
" " hard	80	36	tensile	tensile	¾ tens.	29000000	15.0
" reinforcing bars*, plain, structural grade	55-70	33	tensile	tensile	¾ tens.	29000000	25.4-20.0
" " " " intermediate	70-85	40	tensile	tensile	¾ tens.	29000000	18.6-15.3
" " " " hard	80	50	tensile	tensile	¾ tens.	29000000	15.0
" " " deformed, struct'l grade	55-70	33	tensile	tensile	¾ tens.	29000000	22.7-17.9
" " " " intermediate	70-85	40	tensile	tensile	¾ tens.	29000000	16.1-13.2
" " " " hard	80	50	tensile	tensile	¾ tens.	29000000	12.5
" " " cold twisted		55	tensile	tensile	¾ tens.	29000000	5.0
" rivets*, boilers	45-55	½ tens.	tensile	tensile	¾ tens.	29000000	33.3-27.3
" " bridges	46-56	½ tens.	tensile	tensile	¾ tens.	29000000	32.6-26.8
" " buildings	46-56	½ tens.	tensile	tensile	¾ tens.	29000000	30.4-25.0
" " cars	48-58	½ tens.	tensile	tensile	¾ tens.	29000000	31.3-25.9
" " ships	55-65	½ tens.	tensile	tensile	¾ tens.	29000000	27.3-23.0

STRENGTH OF MATERIALS

STRESS IN KIPS PER SQUARE INCH

Metals and Alloys	Tension, Ultimate	Elastic Limit	Compression, Ultimate	Bending, Ultimate	Shearing, Ultimate	Modulus of Elasticity, Pounds	Elongation, %
Steel Shapes, bridges	55–65	½ tens.	tensile	tensile	¾ tens.	29000000	27.3–23.0
" " buildings	55–65	½ tens.	tensile	tensile	¾ tens.	29000000	25.4–21.5
" " cars	50–65	½ tens.	tensile	tensile	¾ tens.	29000000	30.0–23.0
" " locomotives	55–65	½ tens.	tensile	tensile	¾ tens.	29000000	27.3–23.0
" " ships	58–68	½ tens.	tensile	tensile	¾ tens.	29000000	25.9–22.1
Steel Alloys, Nickel Steel,* 3.25% N.							
" " " shapes, plates, bars	85–100	50	tensile	tensile	¾ tens.	29000000	17.6–15.0
" " " rivets	70–80	45	tensile	tensile	¾ tens.	29000000	21.4–18.8
" " " eye bars, unannealed	95–110	55	tensile	tensile	¾ tens.	29000000	15.8–13.6
" " " " " annealed	90–105	52	tensile	tensile	¾ tens.	29000000	20.0
" " Copper Steel, 0.50% Cu	60–68	37–38	tensile	tensile	¾ tens.	29000000	29.0–23.0
Steel Springs, untempered	65–110	40–70	.....	....	....	....	....
Steel Wire, unannealed	120	60	......	....	....	....	....
" " annealed	80	40	......	....	....	....	....
" " bridge cable	200	95	......	....	....	....	....
Tin, cast	3.5–4.6	1.5–1.8	6	4	....	4000000	....
" antimony, 10 Sn, 1 Sb	11	....	......	....	....	....	....
Zinc, cast	4–6	4	18	7	....	13000000	....
" rolled sheets	7–16	....	......	....	....	....	....

STRESS IN POUNDS PER SQUARE INCH

Building Materials	Ultimate Average Stress			Modulus of Elasticity	Safe Working Stress		
	Compress	Tension	Bending		Compress.	Bearing	Shearing
Brick, Common, good	10000	200	600	....	....	....	....
" " medium burned	11000	....	......	....	....	....	....
" " hard burned	15000	....	......	....	....	....	....
" Pressed and paving	6000	....	.....	....	....	....	....
Concrete. **							
Masonry, Granite	......	....	......	....	420	600	....
" Limestone, bluestone	......	....	......	....	350	500	....
" Sandstone	......	....	......	....	280	400	....
" Rubble	......	....	......	....	140	250	....
" " coursed	.... .	....	......	....	168	250	....
" Brick, common	......	....	......	....	168	300	....
" " hard burned	......	....	......	....	210	300	....
Stone, Bluestone	12000	1200	2500	7000000	1200	1200	200
" Granite, gneiss	12000	1200	1600	7000000	1200	1200	200
" Limestone, marble	8000	800	1500	7000000	800	800	150
" Sandstone	5000	150	1200	3000000	500	500	150
" Slate	10000	3000	5000	14000000	1000	1000	175
Miscellaneous, Glass, common	30000	3000	3000	8000000	....	....	....
" " flooring	10000	3000	3000	....	....	....	....
" Plaster	700	70	......	....	....	....	....
" Terra cotta	5000	....	......	....	....	....	....
" Ropes, cast steel hoisting	......	80000	......	....	....	....	....
" " standing, derrick	......	70000	......	....	....	....	....
" " manila	......	8000	......	....	....	....	....
" Belts, solid woven, cotton	......	7300	......	....	....	....	....
" " " " flax	......	9900	......	....	....	....	....

*See Specifications of the American Society for Testing Materials.

**Extensive laboratory tests recently conducted, indicate that the water cement ratio in con rete mixtures has a very important influence on the ultimate strength of the finished product. Data on this subject can be obtained from the Portland Cement Association, Chicago.

SPECIFIC GRAVITIES AND WEIGHTS

Metals, Alloys, Ores

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Aluminum, cast-hammered	2.55–2.75	165
Aluminum, bronze	7.7	481
Brass, cast-rolled	8.4–8.7	534
Bronze, 7.9 to 14% Sn	7.4–8.9	509
Copper, cast-rolled	8.8–9.0	556
Copper ore, pyrites	4.1–4.3	262
Gold, cast-hammered	19.25–19.3	1205
Iron, cast, pig	7.2	450
Iron, wrought	7.6–7.9	485
Iron, steel	7.8–7.9	490
Iron, spiegel-eisen	7.5	468
Iron, ferro-silicon	6.7–7.3	437
Iron ore, hematite	5.2	325
Iron ore, hematite in bank	.....	160–180
Iron ore, hematite loose	.....	130–160
Iron ore, limonite	3.6–4.0	237
Iron ore, magnetite	4.9–5.2	315
Iron slag	2.5–3.0	172
Lead	11.37	710
Lead ore, galena	7.3–7.6	465
Manganese	7.2–8.0	475
Manganese ore, pyrolusite	3.7–4.6	259
Mercury	13.6	849
Nickel	8.9–9.2	565
Nickel, monel metal	8.8–9.0	556
Platinum, cast-hammered	21.1–21 5	1330
Silver, cast-hammered	10.4–10.6	656
Tin, cast-hammered	7.2–7.5	459
Tin ore, cassiterite	6.4–7.0	418
Zinc, cast-rolled	6.9–7.2	440
Zinc ore, blende	3.9–4.2	253

Various Solids

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Cereals, oats, bulk	.....	32
Cereals, barley, bulk	.....	39
Cereals, corn, rye, bulk	.....	48
Cereals, wheat, bulk	.....	48
Hay and Straw, bales	.....	20
Cotton, Flax, Hemp	1.47–1.50	93
Fats	0.90–0.97	58
Flour, loose	0.40–0.50	28
Flour, pressed	0.70–0.80	47
Glass, common	2.40–2.60	156
Glass, plate or crown	2.45–2.72	161
Glass, crystal	2.90–3.00	184
Leather	0.86–1.02	59
Paper	0.70–1.15	58
Potatoes, piled	.....	42
Rubber, caoutchouc	0.92–0.96	59
Rubber goods	1.0–2.0	94
Salt, granulated, piled	.....	48
Saltpeter	.....	67
Starch	1.53	96
Sulphur	1.93–2.07	125
Wool	1.32	82

Timber, U. S. Seasoned

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Ash, white-red	0.62–0.65	40
Cedar, white-red	0.32 0.38	22
Chestnut	0.66	41
Cypress	0.48	30
Fir, Douglas spruce	0.51	32
Fir, eastern	0.40	25
Elm, white	0.72	45
Hemlock	0.42–0.52	29
Hickory	0.74–0.84	49
Locust	0.73	46
Maple, hard	0.68	43
Maple, white	0.53	33
Oak, chestnut	0.86	54
Oak, live	0.95	59
Oak, red, black	0.65	41
Oak, white	0.74	46
Pine, Oregon	0.51	32
Pine, red	0.48	30
Pine, white	0.41	26
Pine, yellow, long-leaf	0.70	44
Pine, yellow, short-leaf	0.61	38
Poplar	0.48	30
Redwood, California	0.42	26
Spruce, white, black	0.40 0.46	27
Walnut, black	0.61	38
Walnut, white	0.41	26
Moisture Contents:		
Seasoned timber 15 to 20%		
Green timber up to 50%		

Various Liquids

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Alcohol, 100%	0.79	49
Acids, muriatic 40%	1.20	75
Acids, nitric 91%	1.50	94
Acids, sulphuric 87%	1.80	112
Lye, soda 66%	1.70	106
Oils, vegetable	0.91–0.94	58
Oils, mineral, lubricants	0.90–0.93	57
Water, 4°C, max. density	1.0	62.428
Water, 100°C	0.9584	59.830
Water, ice	0.88–0.92	56
Water, snow, fresh fallen	.125	8
Water, sea water	1.02–1.03	64

Gases, Air = 1

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Air, 0°C, 760 mm	1.0	.08071
Ammonia	0.5920	.0478
Carbon dioxide	1.5291	.1234
Carbon monoxide	0.9673	.0781
Gas, illuminating	0.35–0.45	.028–.036
Gas, natural	0.47–0.48	.038–.039
Hydrogen	0.0693	.00559
Nitrogen	0.9714	.0784
Oxygen	1.1056	.0892

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped or loose material, etc.

SPECIFIC GRAVITIES AND WEIGHTS

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Ashlar Masonry		
Granite, syenite, gneiss	2.3–3.0	165
Limestone, marble	2.3–2.8	160
Sandstone, bluestone	2.1–2.4	140
Mortar Rubble Masonry		
Granite, syenite, gneiss	2.2–2.8	155
Limestone, marble	2.2–2.6	150
Sandstone, bluestone	2.0–2.2	130
Dry Rubble Masonry		
Granite, syenite, gneiss	1.9–2.3	130
Limestone, marble	1.9–2.1	125
Sandstone, bluestone	1.8–1.9	110
Brick Masonry		
Pressed brick	2.2–2.3	140
Common brick	1.8–2.0	120
Soft brick	1.5–1.7	100
Concrete Masonry		
Cement, stone, sand	2.2–2.4	144
Cement, slag, etc	1.9–2.3	130
Cement, cinder, etc	1.5–1.7	100
Various Building Mat'l		
Ashes, cinders	....	40–45
Cement, portland, loose	....	90
Cement, portland, set	2.7–3.2	183
Lime, gypsum, loose	....	53–64
Mortar, set	1.4–1.9	103
Slags, bank slag	....	67–72
Slags, bank screenings	....	98–117
Slags, machine slag	....	96
Slags, slag sand	....	49–55
Earth, etc., Excavated		
Clay, dry	....	63
Clay, damp, plastic	....	110
Clay and gravel, dry	....	100
Earth, dry, loose	....	76
Earth, dry, packed	....	95
Earth, moist, loose	....	78
Earth, moist, packed	....	96
Earth, mud, flowing	....	108
Earth, mud, packed	....	115
Riprap, limestone	....	80–85
Riprap, sandstone	....	90
Riprap, shale	....	105
Sand, gravel, dry, loose	....	90–105
Sand, gravel, dry, packed	....	100–120
Sand, gravel, dry, wet	....	118–120
Excavations in Water		
Sand or gravel	....	60
Sand or gravel and clay	....	65
Clay	....	80
River mud	....	90
Soil	....	70
Stone riprap	....	65

Substance	Specific Gravity	Weight, Pounds per Cu. Ft.
Minerals		
Asbestos	2.1–2.8	153
Barytes	4.50	281
Basalt	2.7–3.2	184
Bauxite	2.55	159
Borax	1.7–1.8	109
Chalk	1.8–2.6	137
Clay, marl	1.8–2.6	137
Dolomite	2.9	181
Feldspar, orthoclase	2.5–2.6	159
Gneiss, serpentine	2.4–2.7	159
Granite, syenite	2.5–3.1	175
Greenstone, trap	2.8–3.2	187
Gypsum, alabaster	2.3–2.8	159
Hornblende	3.0	187
Limestone, marble	2.5–2.8	165
Magnesite	3.0	187
Phosphate rock, apatite	3.2	200
Porphyry	2.6–2.9	172
Pumice, natural	0.37–0.90	40
Quartz, flint	2.5–2.8	165
Sandstone, bluestone	2.2–2.5	147
Shale, slate	2.7–2.9	175
Soapstone, talc	2.6–2.8	169
Stone, Quarried, Piled		
Basalt, granite, gneiss	....	96
Limestone, marble, quartz	....	95
Sandstone	.....	82
Shale	....	92
Greenstone, hornblende	.....	107
Bituminous Substances		
Asphaltum	1.1–1.5	81
Coal, anthracite	1.4–1.7	97
Coal, bituminous	1.2–1.5	84
Coal, lignite	1.1–1.4	78
Coal, peat, turf, dry	0.65–0.85	47
Coal, charcoal, pine	0.28–0.44	23
Coal, charcoal, oak	0.47–0.57	33
Coal, coke	1.0–1.4	75
Graphite	1.9–2.3	131
Paraffine	0.87–0.91	56
Petroleum	0.87	54
Petroleum, refined	0.79–0.82	50
Petroleum, benzine	0.73–0.75	46
Petroleum, gasoline	0.66–0.69	42
Pitch	1.07–1.15	69
Tar, bituminous	1.20	75
Coal and Coke, Piled		
Coal, anthracite	.....	47–58
Coal, bituminous, lignite	.....	40–54
Coal, peat, turf	.....	20–26
Coal, charcoal	.....	10–14
Coal, coke	.....	23–32

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped or loose material, etc.

PROPERTIES OF AMERICAN STANDARD YARD LUMBER AND TIMBER SIZES

NATIONAL LUMBER MANUFACTURERS ASSOCIATION

Nominal Size	American Standard Dressed Size	Area of Section $A = bd$	Weight per Lineal foot	Moment of Inertia $I = \frac{bd^3}{12}$	Section Modulus $S = \frac{bd^2}{6}$
Inches	Inches	Sq. In.	Pounds		
2×4	1⅝×3⅝	5.89	1.6	6.45	3.56
2×6	1⅝×5⅝	9.14	2.5	24.10	8.57
2×8	1⅝×7½	12.19	3.4	57.13	15.32
2×10	1⅝×9½	15.44	4.3	116.09	24.44
2×12	1⅝×11½	18.69	5.2	205.94	35.82
2×14	1⅝×13½	23.62	6.5	333.15	49.36
2×16	1⅝×15½	25.18	7.0	504.24	65.07
2×18	1⅝×17½	28.43	7.9	725.71	82.94
2×20	1⅝×19½	31.69	8.8	1004.05	102.98
3×4	2⅝×3⅝	9.51	2.6	10.42	5.75
3×6	2⅝×5⅝	14.76	4.2	38.93	13.84
3×8	2⅝×7½	19.68	5.7	92.28	24.60
3×10	2⅝×9½	24.93	7.2	187.55	39.48
3×12	2⅝×11½	30.18	8.8	332.69	57.86
3×14	2⅝×13½	35.43	10.3	538.21	79.73
3×16	2⅝×15½	40.68	11.3	814.60	105.11
3×18	2⅝×17½	45.94	12.8	1172.36	133.98
3×20	2⅝×19½	51.19	14.2	1622.00	166.36
4×4	3⅝×3⅝	13.14	3.6	14.38	7.94
4×6	3⅝×5⅝	20.39	5.7	53.76	19.11
4×8	3⅝×7½	27.18	7.5	127.44	33.98
4×10	3⅝×9½	34.43	9.6	258.99	54.52
4×12	3⅝×11½	41.68	11.6	459.42	79.90
4×14	3⅝×13½	48.93	13.6	743.23	110.11
4×16	3⅝×15½	56.18	15.6	1124.90	145.15
4×18	3⅝×17½	63.43	17.6	1618.96	185.02
4×20	3⅝×19½	70.69	19.6	2239.88	229.73
6×6	5½×5½	30.25	8.4	76.25	27.73
6×8	5½×7½	41.25	11.4	193.35	51.56
6×10	5½×9½	52.25	14.5	329.96	82.73
6×12	5½×11½	63.25	17.5	697.06	121.23
6×14	5½×13½	74.25	20.6	1127.66	167.06
6×16	5½×15½	85.25	23.6	1706.76	220.22
6×18	5½×17½	96.25	26.7	2456.36	280.73
6×20	5½×19½	107.25	29 8	3398.46	348.56
6×22	5½×21½	118.25	32.8	4555.05	423.73
8×8	7½×7½	56.25	15.6	263.67	70.31
8×10	7½×9½	71.25	19.8	535.85	112.81
8×12	7½×11½	86.25	23.9	950.55	165.31
8×14	7½×13½	101.25	28.0	1537.73	227.81
8×16	7½×15½	116.25	32.0	2327.42	300.31
8×18	7½×17½	131.25	36.4	3349.60	382.81
8×20	7½×19½	146.25	40.6	4634.30	475.31
8×22	7½×21½	161.25	44.8	6211.48	577.81
8×24	7½×23½	176.25	48.9	8111.17	690.31
10×10	9½×9½	90.25	25.0	678.75	142.89
10×12	9½×11½	109.25	30.3	1204.01	209.39
10×14	9½×13½	128.25	35.6	1947.78	288.56
10×16	9½×15½	147.25	40.9	2948.04	380.39
10×18	9½×17½	166.25	46.1	4242.80	484.89

Nominal Size	American Standard Dressed Size	Area of Section $A = bd$	Weight per Lineal foot	Moment of Inertia $I = \frac{bd^3}{12}$	Section Modulus $S = \frac{bd^2}{6}$
Inches	Inches	Sq. In.	Pounds		
10×20	9½×19½	185.25	51.4	5870.05	602.06
10×22	9½×21½	204.25	56.7	7867.81	731.89
10×24	9½×23½	223.25	62.0	10274.06	874.39
10×26	9½×25½	242.25	67.3	13126.81	1029.56
10×28	9½×27½	261.25	72.5	16465.24	1197.39
10×30	9½×29½	280.25	77.8	20323.79	1377.89
12×12	11½×11½	132.25	36.7	1457.50	253.47
12×14	11½×13½	155.25	43.1	2357.85	349.31
12×16	11½×15½	178.25	49.5	3568.70	460.48
12×18	11½×17½	201.25	55.9	5136.49	586.98
12×20	11½×19½	224.25	62.3	7105.90	728.81
12×22	11½×21½	247.25	68.7	9524.24	885.98
12×24	11½×23½	270.25	75.0	12437.08	1058.47
12×26	11½×25½	293.25	81.4	15890.42	1246.31
12×28	11½×27½	316.25	87.8	19932.58	1449.47
12×30	11½×29½	339.25	94.2	24602.61	1667.97
14×14	13½×13½	182.25	50.6	2767.92	410.06
14×16	13½×15½	209.25	58.1	4189.36	540.56
14×18	13½×17½	236.25	65.6	6029.29	689.06
14×20	13½×19½	263.25	73.1	8341.73	855.56
14×22	13½×21½	290.25	80.6	11180.67	1040.06
14×24	13½×23½	317.25	88.1	14600.10	1242.56
14×26	13½×25½	344.25	95.6	18654.04	1463.06
14×28	13½×27½	371.25	103.1	23398.73	1701.56
14×30	13½×29½	398.25	110.6	28881.42	1958.06
16×16	15½×15½	240.25	66.7	4809.98	620.64
16×18	15½×17½	271.25	75.3	6922.49	791.14
16×20	15½×19½	302.25	83.9	9577.50	982.31
16×22	15½×21½	333.25	92.5	12837.00	1194.14
16×24	15½×23½	364.25	101.2	16763.00	1426.64
16×26	15½×25½	395.25	109.8	21417.50	1679.81
16×28	15½×27½	426.25	118.4	26863.78	1953.64
16×30	15½×29½	457.25	127.0	33159.98	2248.14
18×18	17½×17½	306.25	85.0	7815.73	893.23
18×20	17½×19½	341.25	94.8	10813.33	1109.06
18×22	17½×21½	376.25	104.5	14493.43	1348.23
18×24	17½×23½	411.25	114.2	18926.02	1610.72
18×26	17½×25½	446.25	123.9	24181.11	1896.56
18×28	17½×27½	481.25	133.7	30331.62	2205.72
18×30	17½×29½	516.25	143.4	37438.79	2538.22
20×20	19½×19½	380.25	105.6	12049.49	1235.81
20×22	19½×21½	419.25	116.4	16149.86	1502 31
20×24	19½×23½	458.25	127.3	21089.04	1794.81
20×26	19½×25½	497.25	138.1	26944.73	2113.31
20×28	19½×27½	536.25	148.9	33798.17	2457.81
20×30	19½×29½	575.25	159.8	41717.61	2828.31
24×24	23½×23½	552.25	153.4	25414.96	2162.97
24×26	23½×25½	599.25	166.4	32471.80	2546.81
24×28	23½×27½	646.25	179.5	40731.06	2916.97
24×30	23½×29½	693.25	192.5	50274.98	3408.47

The weights given above are based on assumed average weight of 40 lbs. per cubic foot.

SAFE LOAD IN POUNDS PER SQUARE INCH OF CROSS-SECTIONAL AREA
SQUARE AND RECTANGULAR TIMBER COLUMNS
DRY LOCATIONS

Species of Lumber	American Standard Grade	*Ratio of Length to Least Dimension (*l/d*) 10& less	*l/d* 12	*l/d* 14	*l/d* 16	*l/d* 18	*l/d* 20	*l/d* 25	*l/d* 30	*l/d* 35	*l/d* 40	*l/d* 50
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Ash, Commercial White	Select	1100	1076	1055	1023	978	913	658	457	336	257	164
	Common	880	868	857	840	818	784	647				
Cedar, Western Red; Fir, Balsam	Select	700	686	674	656	629	592	438	304	224	171	110
	Common	560	553	547	538	524	505	425				
Cedar, Northern and Southern White	Select	550	540	530	516	496	468	351	244	179	137	88
	Common	440	435	430	423	412	398	338				
Chestnut; Pine, Northern White, Idaho White, Sugar, Calif. White, and Pondosa	Select	750	733	718	695	663	617	438	304	224	171	110
	Common	600	591	583	572	556	532	434				
Cypress, Southern; Larch, Western	Select	1100	1063	1030	981	909	810	526	365	268	206	132
	Common	880	861	843	818	781	729					
Douglas Fir (Coast Region); Pine, Southern Yellow; Beech; Birch, Yellow and Sweet; Maple, Sugar	**Dense Select	1285	1251	1222	1176	1112	1022	702	487	358	274	175
	Select	1175	1149	1127	1093	1045	975	702				
	Common	880	870	861	847	826	796	675				
Douglas Fir (Rky. Mtn. Region); Spruce, Red, White, Sitka; Norway Pine; Alaska Cedar; Elm, Slippery and White; Sycamore; Gum, Red and Black; Tupelo	Select	800	786	774	753	726	688	526	365	268	206	132
	Common	640	632	627	617	602	582	500				
Hemlock, West Coast	Select	900	885	872	852	823	783	614	426	313	240	153
	Common	720	712	706	696	680	660	573				
Hemlock, Eastern; Fir, Commercial White	Select	700	689	678	664	641	611	482	335	246	188	121
	Common	560	554	549	542	530	515	449				
Oak, White and Red	Select	1000	982	967	943	908	860	658	457	336	257	164
	Common	800	790	783	771	753	728	625				
Redwood	Select	1000	972	947	910	856	781	526	365	268	206	132
	Common	800	786	773	754	726	688					
Spruce, Englemann	Select	600	586	574	556	530	494	351	244	179	137	88
	Common	480	473	466	457	444	426	347				
Tamarack	Select	1000	976	955	923	877	817	570	396	291	223	142
	Common	800	788	777	761	737	706	566				

SAFE LOADS in compression parallel to grain for timber columns shall not exceed in pounds per square inch the values given in the above table for the respective species, grade, and ratio of unsupported length to least dimension, (*l/d*).

No column shall be used in which the unsupported length is more than 50 times the least diameter. *l* and *d* must be figured in the same unit of measurement.

ALLOWABLE UNIT STRESSES FOR STRUCTURAL LUMBER AND TIMBER

ALL SIZES, DRY LOCATIONS

Species of Timber	American Standard Grade	Allowable Unit Stress in Pounds per Square Inch				
		Bending Stress		Compression Stress		Modulus of Elasticity (All Locations)
		In Extreme Fibre	Horizontal Shear All Locations	Parallel to Grain	Perpendicular to Grain	
Cedar, Western Red	Select Common	900 720	80 64	700 560	200	1000000
Cedar, Northern and Southern White	Select Common	750 600	70 56	550 440	175	800000
Cedar, Port Orford	Select Common	1100 880	90 72	900 720	250	1200000
Cedar, Alaska	Select Common	1100 880	90 72	800 640	250	1200000
Cypress, Southern	Select Common	1300 1040	100 80	1100 880	350	1200000
Douglas Fir, Coast Region (Western Washington and Oregon)	Dense Select Select Common	1750 1600 1200	105 90 72	1285 1175 880	380 345 325	1600000
Douglas Fir, Rocky Mountain Region	Select Common	1100 880	85 68	800 640	275	1200000
Fir, Balsam	Select Common	900 720	70 56	700 560	150	1000000
Fir, Golden, Noble, Silver, White (Commercial White)	Select Common	1100 880	70 56	700 560	300	1100000
Hemlock, West Coast	Select Common	1300 1040	75 60	900 720	300	1400000
Hemlock, Eastern	Select Common	1100 880	70 56	700 560	300	1100000
Larch, Western	Select Common	1200 960	100 80	1100 880	325	1300000
Oak, Commercial White and Red	Select Common	1400 1120	125 100	1000 800	500	1500000
Pine, Southern Yellow	Dense Select Select Common	1750 1600 1200	128 110 88	1285 1175 880	380 345 325	1600000
Pine, Calif., Idaho and No. White, Lodgepole, Pondosa, Sugar, Westn. Yellow	Select Common	900 720	85 68	750 600	250	1000000
Pine, Norway	Select Common	1100 880	85 68	800 640	300	1200000
Redwood	Select Common	1200 960	70 56	1000 800	250	1200000
Spruce, Red, White, Sitka	Select Common	1100 880	85 68	800 640	250	1200000
Spruce, Englemann	Select Common	750 600	70 56	600 480	175	800000
Tamarack, Eastern	Select Common	1200 960	95 76	1000 800	300	1300000

The allowable working stresses given above are taken from recommendations of the Forest Products Laboratory of the Department of Agriculture at Madison, Wisconsin, for use in dry locations. The grades for which stresses are given are for dimension lumber and timber equivalent in quality to the American Standards for Structural Material as published by the Bureau of Standards, U. S. Department of Commerce, in Simplified Practice Recommendation No. 16.
These grades and stresses have been adopted by the American Railway Engineering Association, accepted by the American Society for Testing Materials, and are recommended by the Building Code Committee of the Department of Commerce.
All computations to determine the required size of lumber members should be based on the net cross sectional area or actual size.

ALLOWABLE UNIT STRESSES FOR STRUCTURAL LUMBER AND TIMBER

USED IN LOCATIONS USUALLY WET

Species	Grade	Allowable Unit Stress in Pounds per Square Inch					
		Bending Stress			Compression Stress		Modulus of Elasticity
		In Extreme Fibre		Horizontal Shear	Parallel to Grain	Perpendicular to Grain	
		Joist and Plank Sizes 4" and less in thickness	Beam and Stringer Sizes 5" & thicker				
Cedar, Western Red	Select Common	670 570	750 600	80 64	650 520	125	1000000
Cedar, Northern & Southern White	Select Common	530 450	....	70 56	... ...	100	800000
Cedar, Port Orford	Select Common	800 680	900 720	90 72	750 600	150	1200000
Cedar, Alaska	Select Common	800 680	... ..	90 72	. ...	150	1200000
Cypress, Southern	Select Common	800 680	... ..	100 80	... ...	225	1200000
Douglas Fir, Coast Region (Western Washington and Oregon)	Dense Select Select Common	1050 950 750	1165 1065 800	105 90 72	990 905 680	235 215 200	1600000
Douglas Fir, Rocky Mountain Region	Select Common	620 530	700 560	85 68	700 560	200	1200000
Fir, Balsam	Select Common	530 450	....	70 56	.. ...	100	1000000
Fir, Golden, Noble, Silver, White (Commercial White)	Select Common	710 600	....	70 56	... ...	200	1100000
Hemlock, West Coast	Select Common	800 680	900 720	75 60	800 640	200	1400000
Hemlock, Eastern	Select Common	710 600	... .	70 56	.. ..	200	1100000
Larch, Western	Select Common	800 680	900 720	100 80	800 640	200	1300000
Pine, Southern	Dense Select Select Common	1050 950 750	1165 1065 800	128 110 88	990 905 680	235 215 200	1600000
Pine, Calif., Idaho and No. White, Lodgepole, Pondosa and Sugar	Select Common	670 570	... .	85 68	... ...	125	1000000
Pine, Norway	Select Common	710 600	....	85 68	... ...	150	1200000
Redwood	Select Common	710 600	800 640	70 56	750 600	125	1200000
Spruce, Red, White, Sitka	Select Common	710 600	800 640	85 68	650 520	125	1200000
Spruce, Englemann	Select Common	440 370	... .	70 56	.. ...	100	800000
Tamarack, Eastern	Select Common	800 680	....	95 76	... ...	200	1300000

The strength of wood is influenced largely by its moisture content, and therefore by the moisture conditions of service, which have an important bearing also on decay and checking. The allowable working stresses given above are taken from recommendations of the Forest Products Laboratory of the Department of Agriculture at Madison, Wisconsin, for use in locations where the lumber will be usually wet.

The grades for which stresses are given are for dimension lumber and timber equivalent in quality to the American Standards for Structural Material as published by the Bureau of Standards, U. S. Department of Commerce, in Simplified Practice Recommendation No. 16. These grades and stresses have been adopted by the American Railway Engineering Association, accepted by the American Society for Testing Materials, and are recommended by the Building Code Committee of the Department of Commerce.

All computations to determine the required size of lumber members should be based on the net cross sectional area or actual size.

CONTENTS OF STORAGE WAREHOUSES

Material	Weights per Cubic Foot of Space, Pounds	Height of Pile Feet	Weights per Square Foot of Floor Pounds	Recommended Live Loads, Pounds per Square Foot
Building Materials				
Asbestos	50	6	300	
Bricks, Building	45	6	270	
Bricks, Fire Clay	75	6	450	
Cement, Natural	59	6	354	300
Cement, Portland	73	6	438	to
Gypsum	50	6	300	400
Lime and Plaster	53	5	265	
Tiles	50	6	300	
Woods, bulk	45	6	270	
Drugs, Paints, Oil, Etc.				
Alum, Pearl, in barrels	33	6	198	
Bleaching Powder, in hogsheads	31	3½	102	
Blue Vitriol, in barrels	45	5	226	
Glycerine, in cases	52	6	312	
Linseed Oil, in barrels	36	6	216	
Linseed Oil, in iron drums	45	4	180	
Logwood Extract, in boxes	70	5	350	
Rosin, in barrels	48	6	288	200
Shellac, Gum	38	6	228	to
Soaps	50	6	300	300
Soda Ash, in hogsheads	62	2¾	167	
Soda, Caustic, in iron drums	88	3⅜	294	
Soda, Silicate, in barrels	53	6	318	
Sulphuric Acid	60	1⅝	100	
Toilet Articles	35	6	210	
Varnishes	55	6	330	
White Lead Paste, in cans	174	3½	610	
White, Lead, dry	86	4¾	408	
Red Lead and Litharge, dry	132	3¾	495	
Dry Goods, Cotton, Wool, Etc.				
Burlap, in bales	43	6	258	
Carpets and Rugs	30	6	180	
Coir Yarn, in bales	33	8	264	
Cotton, in bales, American	30	8	240	
Cotton, in bales, Foreign	40	8	320	
Cotton Bleached Goods, in cases	28	8	224	
Cotton Flannel, in cases	12	8	96	
Cotton Sheeting, in cases	23	8	184	
Cotton Yarn, in cases	25	8	200	200
Excelsior, compressed	19	8	152	to
Hemp, Italian, compressed	22	8	176	250
Hemp, Manila, compressed	30	8	240	
Jute, compressed	41	8	328	
Linen Damask, in cases	50	5	250	
Linen Goods, in cases	30	8	240	
Linen Towels, in cases	40	6	240	
Silk and Silk Goods	45	8	360	
Sisal, compressed	21	8	168	
Tow, compressed	29	8	232	
Wool, in bales, compressed	48			
Wool, in bales, not compressed	13	8	104	
Wool, Worsteds, in cases	27	8	216	

CONTENTS OF STORAGE WAREHOUSES

Material	Weights per Cubic Foot of Space, Pounds	Height of Pile Feet	Weights per Square Foot of Floor Pounds	Recommended Live Loads, Pounds per Square Foot
Groceries, Wines, Liquors, Etc.				
Beans, in bags	40	8	320	
Beverages	40	8	320	
Canned Goods, in cases	58	6	348	
Cereals	45	8	360	
Cocoa	35	8	280	
Coffee, Roasted, in bags	33	8	264	
Coffee, Green, in bags	39	8	312	
Dates, in cases	55	6	330	
Figs, in cases	74	5	370	
Flour, in barrels	40	5	200	
Fruits, Fresh	35	8	280	250 to 300
Meat and Meat Products	45	6	270	
Milk, Condensed	50	6	300	
Molasses, in barrels	48	5	240	
Rice, in bags	58	6	348	
Sal Soda, in barrels	46	5	230	
Salt, in bags	70	5	350	
Soap Powder, in cases	38	8	304	
Starch, in barrels	25	6	150	
Sugar, in barrels	43	5	215	
Sugar, in cases	51	6	306	
Tea, in chests	25	8	200	
Wines and Liquors, in barrels	38	6	228	
Hardware, Etc.				
Automobile Parts	40	8	320	
Chain	100	6	600	
Cutlery	45	8	360	
Door Checks	45	6	270	
Electrical Goods and Machinery	40	8	320	
Hinges	64	6	384	
Locks, in cases, packed	31	6	186	
Machinery, Light	20	8	160	300 to 400
Plumbing, Fixtures	30	8	240	
Plumbing, Supplies	55	6	330	
Sash Fasteners	48	6	288	
Screws	101	6	606	
Shafting Steel	125			
Sheet Tin, in boxes	278	2	556	
Tools, Small, Metal	75	6	450	
Wire Cables, on reels			425	
Wire, Insulated Copper, in coils	63	5	315	
Wire, Galvanized Iron, in coils	74	4½	333	
Wire, Magnet, on spools	75	6	450	
Miscellaneous				
Automobile Tires	30	6	180	
Automobiles, uncrated	8		64	
Books (solidly packed)	65	6	390	
Furniture	20			
Glass and Chinaware, in crates	40	8	320	
Hides and Leather, in bales	20	8	160	
Hides, Buffalo, in bundles	37	8	296	
Leather and Leather Goods	40	8	320	
Paper, Newspaper, and Strawboards	35	6	210	
Paper, Writing and Calendared	60	6	360	
Rope, in coils	32	6	192	
Rubber, Crude	50	8	400	
Tobacco, bales	35	8	280	

CORRUGATED SHEETS

DIMENSIONS

Corrugations: Width in Inches, Nominal	Corrugations: Width in Inches, Actual	Corrugations: Depth in Inches	Corrugations: Number per Sheet	Sheets: Full Sheet Width	Sheets: Covering Width	Length of Sheet in Inches	Area in Sq. Feet of One Sheet, Corrugations 5″	Area in Sq. Feet of One Sheet, Corrugations 2″, 2½″ 3″	Area in Sq. Feet of One Sheet, Corrugations ⅝″ 1¼″	Number of Sheets in 100 Sq. Feet, Corrugations 5″	Number of Sheets in 100 Sq. Feet, Corrugations 2″, 2½″ 3″	Number of Sheets in 100 Sq. Feet, Corrugations ⅝″ 1¼″
5	5	7/8	6	28	25	60	11.67	10.83	10.42	8.57	9.23	9.60
3	3	9/16	9	26	24	72	14.00	13.00	12.50	7.14	7.69	8.00
*2½	2⅔	½	10½	27½	24	84	16.33	15.17	14.58	6.12	6.59	6.86
2½	2⅔	½	10	26	24	96	18.67	17.33	16.67	5.36	5.77	6.00
2	2	7/16	13	26	24	108	21.00	19.50	18.75	4.76	5.13	5.33
1¼	1¼	⅜	20	25	23¾	120	23.33	21.67	20.83	4.29	4.62	4.80
⅝	⅝	3/16	40	25	24⅜	144	28.00	26.00	25.00	3.57	3.85	4.00

*Sizes given are for 27½″ width.
5, 6, 7, 8, 9 and 10 feet are Standard lengths. Maximum length is 12 ft. except for ⅝″.

WEIGHTS

Pounds per 100 Square Feet

Painted Sheets

Corrugations	10	12	14	16	18	20	21	22	23	24	25	26	27	28	29
	Thickness, United States Standard Gage														
5	...	470	336	269	215	162	148	135	122	108	95	81	75	68	..
3	...	472	338	270	216	163	149	136	122	109	95	82	75	68	..
*2½	615	478	342	274	219	165	151	137	124	110	97	83	76	69	..
2½	607	472	338	270	216	163	149	136	122	109	95	82	75	68	..
2	...	...	...	270	216	163	149	136	122	109	95	82	75	68	..
1¼	...	...	...	...	...	169	155	141	127	113	99	85	78	71	..
⅝	...	...	...	...	...	...	...	...	...	113	99	85	78	71	..

Galvanized Sheets

Corrugations	10	12	14	16	18	20	21	22	23	24	25	26	27	28	29
	Thickness, United States Standard Gage														
5	...	486	352	285	231	178	164	151	137	124	111	97	90	84	77
3	...	488	353	286	232	178	165	151	138	125	111	98	91	84	77
*2½	631	494	358	290	235	181	167	153	140	126	113	99	92	85	78
2½	623	488	353	286	232	178	165	151	138	125	111	98	91	84	77
2	...	...	...	286	232	178	165	151	138	125	111	98	91	84	77
1¼	...	...	...	...	...	186	172	158	144	130	116	102	95	88	81
⅝	...	...	...	...	...	...	...	...	...	130	116	102	95	88	81

The weights given in the above tables are for actual dimensions and do not include allowances for end or side laps.

NUMBER OF SQUARE FEET REQUIRED

2½″ Standard Sheets to cover Area of 100 Square Feet

Side Lap		End Lap in Inches: 1	2	3	4	5	6
Number of Corrugations	1	109	111	112	113	114	116
	1½	116	117	118	120	121	122
	2	123	124	126	127	129	130

The above table is based on the use of standard widths of sheets 96 inches long.
If longer or shorter sheets are used the number of square feet given will vary accordingly.

Laps:— In standard roof construction one and one-half corrugations are allowed for lap in the width of the sheet and six inches in the length.

In standard siding construction one corrugation is allowed for lap in the width of the sheet and four inches in the length.

Part IV

Structural Shapes and Details

Explanation of Specification Formulae

Angles

Channels

Beams

American Standard

Bethlehem

Carnegie

Miscellaneous Beam Sections

Beam Summary

Columns

Bethlehem

Carnegie

Plate and Angle

Plate and Channel

Base Plates

Rivets and Bolts

A. I. S. C. SPECIFICATION FORMULAE

In 1923 the American Institute of Steel Construction undertook the work of promoting uniform practice in the industry, and in order that its efforts would not be interpreted as being unduly influenced by commercial interests it selected a committee from among the leading talent in the academic, engineering and architectural professions to prepare a Standard Specification on the Design, Fabrication, and Erection of Structural Steel. This committee represented a combined experience of approximately one hundred and fifty years in an industry which is not more than thirty-five years old. The personnel was as follows:

GEORGE F. SWAIN:	M. Am Soc C E—M. Am Soc M E—M. Inst C E M. A R E A—Past President, A S C E—Professor of Civil Engineering, Harvard University
MILO S. KETCHUM:	M. Am Soc C E—M. A R E A—Dean of the College of Engineering, and Director of the Engineering Experiment Station of the University of Illinois
E. R. GRAHAM:	of Graham, Anderson, Probst & White, Architects, Chicago, Ill.
W. J. THOMAS:	M. Am Soc C E—Chief Engineer, Geo. B. Post & Sons, Architects, N. Y.
WILBUR J. WATSON:	M. Am Soc C E—M. A R E A—President, Watson Engineering Company, Cleveland, Ohio

It was recognized in their deliberations that the misleading term of "factor of safety" was more the subject of the application of any recommended unit stress than the unit stress itself. They did not undertake to define the qualities and property of steel, which is a proper function of the American Society for Testing Materials, but restricted themselves to a definition of the uses of steel in connection with building construction.

On the following pages is a mathematical explanation of the development of the various formulae recommended in the Specification for the proper reduction of working stresses. The diagram showing various column formulae indicates that a wide difference of opinion has existed on the proper consideration of this subject.

Part IV
Section 1

Explanation of
A. I. S. C. Specification Formulae

Beams

Web Shear and Stiffeners

Laterally Unsupported Flanges

Columns

Rivet Stresses

A. I. S. C. Connection Angles

Column Bases

BEAMS—ALLOWABLE STRESSES

(A. I. S. C. Specification)

All parts of the structure shall be so proportioned that the sum of the maximum static stresses in pounds per sq. in. shall not exceed the following:—

Shearing

On the gross area of the webs of beams and girders, where h, the height between flanges in inches, is not more than 60 times t, the thickness of the web in inches 12000

On the gross area of the webs of beams and girders if the web is not stiffened where h, the height between flanges in inches, is more than 60 times t, the thickness of the web, the maximum shear per square inch, $\frac{V}{A}$ shall not exceed $\dfrac{18000}{1 + \dfrac{h^2}{7200t^2}}$

In which V is the total shear, and A is gross area of web in square inches.

Stiffeners

Stiffeners shall be required on the webs of rolled beams and plate girders at the ends and at points of concentrated loads, and at other points where h the clear distance between flanges is greater than $85t\sqrt{18000\ (A/V)-1}$, in which t is the thickness of the web. When stiffeners are required, the distance in inches between them shall not be greater than $85t\sqrt{18000\ (A/V)-1}$, or not greater than 6 feet. When h is greater than 60 times t the thickness of the web of a plate girder, stiffeners shall be required at distances not greater than 6 feet apart. Stiffeners under or over concentrated loads shall be proportioned to distribute such loads into the web.

BEAMS—WEB SHEAR AND STIFFENERS

The development of formulae appearing in the Specification on this subject is based upon the accepted theory that the vertical shear in the webs of beams and girders may be properly resolved at 45° to the axis of the beam or girder, or at right angles to each other. Numerous tests have been made on beams and girders in which they have been loaded beyond their elastic limit with the result that the mill surface of the material has been broken down along the lines on which the interior material has been distorted. These lines have been photographed and confirm the theory exactly. They indicate that the webs of rolled beams act as multiple lattice trusses, and that riveted plate and angle girders act as pin connected trusses. These strain lines show the stresses acting at exactly 45° to the neutral axis. If the web of a beam or girder

is to fail by buckling this failure would of course develop as a result of the compression stresses acting at 45° to the axis of the girder; and the length of the column would be the square root of $2h^2$ where h is the height between flanges. Over a long period it has been established that until this height is more than 60 times the thickness of the web, there is no danger from buckling. The formula representing the crippling strength of the web is developed as follows:

f_c = average intensity of the allowable compression stress equal 18,000 #

f_s = average intensity of the vertical shear per square inch on the gross section of the web equals 12,000 #

l = length of the compression fibre at 45° between the stiffeners or the flanges, whichever is the smaller.

A = gross area of the web in square inches

V = gross vertical shear on the web

h = distance between flanges or stiffeners, whichever is the smaller

t = thickness of the web

r = least radius of gyration of the web

Therefore, $r = t/\sqrt{12}$ and $l = \sqrt{2h^2}$

The column formula applied to the web of a girder would then be

$$f_s = \frac{f_c}{1 + \frac{l^2}{cr^2}} = \frac{f_c}{1 + \frac{h^2}{c_1 t^2}}$$

c is a constant applying when the ratio l/r is used, and c_1 is a corresponding constant applying when h/t is used.

Solving this equation for h^2/t^2 we have,

$$\frac{h^2}{t^2} = c_1 \left(\frac{f_c}{f_s} - 1 \right)$$

It is now necessary to determine the value of the constant c_1. Conceding the fact that stiffeners are not needed inside the points where h/t equals 60, we may substitute in this formula and get,

$$3600 = c_1 \left(\frac{18000}{12000} - 1 \right)$$

and solving this we have,

$$c_1 = 7200$$

The column formula for web crippling then becomes,

$$\frac{V}{A} = \frac{18000}{1 + \frac{h^2}{7200\, t^2}}$$

and solving this, we have,

$$h = 85\, t \sqrt{18000 \frac{A}{V} - 1}$$

By this analysis and treatment of the webs of beams and girders, we are enabled to so space the stiffeners on a web ½″ thick as to give it the same resistance to buckling as a web 1″ thick would have. It is, of course, obvious that we cannot make the shear of a ½″ web equivalent to the shear of a 1″ web; but we have taken the subject out of the empirical treatment and placed it on a rational basis.

On the opposite page is a chart devised to eliminate the necessity of calculations in finding the allowable vertical shear in the webs of beams and girders, and it also gives the proper spacing of web stiffeners.

The oblique lines through the points on the line which is the scale representing web thickness in inches all pass through zero. These lines intersect verticals from the base line giving the scale of h. The horizontal lines from this intersection give the ratio h/t on the left of the chart and where this horizontal line crosses the curve, gives the allowable shear per square inch in the web, which is read at the top of the chart. By reversing the process, the proper distance between stiffeners is given.

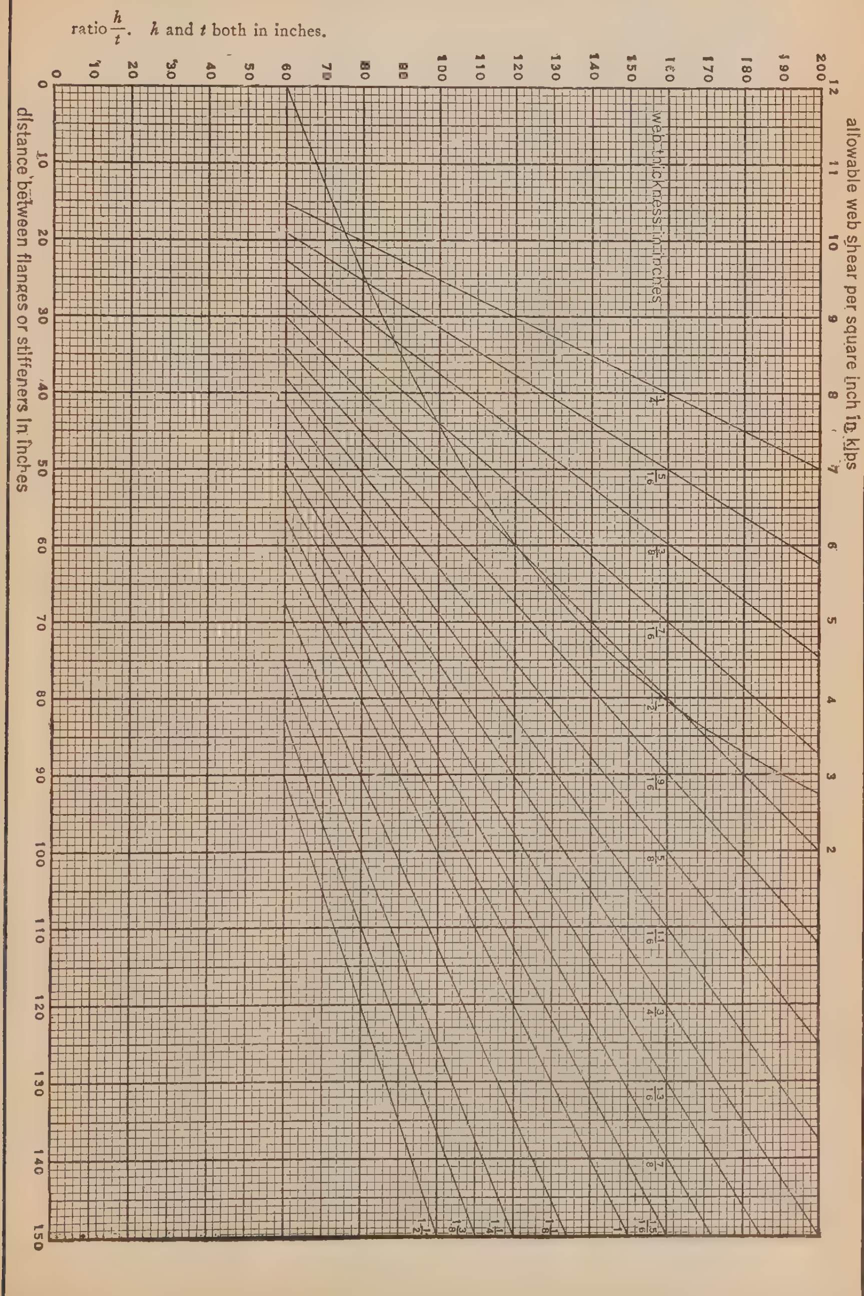
Example:—

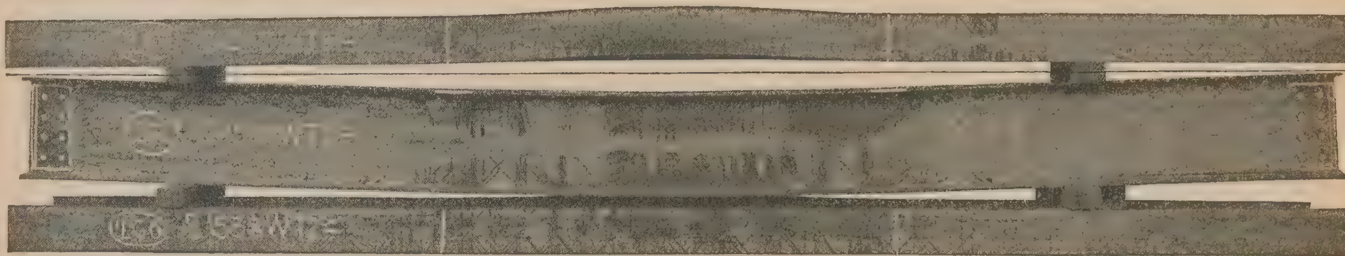
9000 pounds per square inch shear is permitted when h/t equals 85; and if t is ½ inch $h = 42$ inches, which is the maximum distance between stiffeners if the distance between flanges is more than 42 inches.

Below is given the allowable shear per square inch for various ratios of h/t.

h/t	V/A	h/t	V/A	h/t	V/A	h/t	V/A
60	12000	74	10224	87	8775	100	7535
61	11868	75	10105	88	8672	105	7111
62	11734	76	9988	89	8571	110	6722
63	11604	77	9871	90	8471	115	6345
64	11473	78	9756	91	8372	120	6000
65	11343	79	9642	92	8274	125	5678
66	11215	80	9529	93	8177	130	5378
67	11087	81	9418	94	8082	135	5097
68	10961	82	9308	95	7988	140	4836
69	10835	83	9199	96	7895	145	4592
70	10711	84	9091	97	7803	150	4364
71	10587	85	8984	98	7712	155	4151
72	10465	86	8880	99	7623	160	3951
73	10344						

WEB SHEAR AND STIFFENERS CHART





The above illustration is a picture of a 15 inch—38 pound beam 15 feet—11¾ inches long which has been loaded at the third points as indicated by the white marks.

There is a picture of a top and bottom flange shown from which it will be seen that the failure was due to buckling of the compression flange. The line drawn above the beam indicates the permanent set; and the lines on the web are the strain lines which are shown more clearly on an enlarged cut on the next page.

No paint was used on any of these beams, and the cracks in the mill scale are the result of strains beyond the elastic limit of the material.

Enlarged photo of web stress shown on the opposite page.

The above illustration is a picture of a plate and angle girder 27 feet 11½ inches long, fabricated from a 30 x ⅜ inch web plate; and flange angles 6 x 4 x ¾ for the top flange and 6 x 4 x ½ for the bottom flange.

The loads were applied at the third points over the stiffeners and the line drawn above the beam shows the permanent set after the girder was removed from the testing machine. Strain lines are plainly visible radiating at exactly 45° from the various rivets.

BEAMS—ALLOWABLE STRESSES

(A. I. S. C. Specification)

All parts of the structure shall be so proportioned that the sum of the maximum static stresses in pounds per sq. in. shall not exceed the following:—

Bending

On extreme fibres of rolled shapes, and built up sections, net section, if lateral deflection is prevented. 18000

When the unsupported length l exceeds 15 times b, the width of the compression flange, the stress in pounds per sq. in. in the latter shall not exceed

$$\frac{20000}{1 + \dfrac{l^2}{2000b^2}}$$

The laterally unsupported length of beams and girders shall not exceed 40 times b the width of the compression flange.

BEAMS—LATERALLY UNSUPPORTED FLANGES

The question of the stresses in laterally unsupported flanges is of vital importance in the proper design of beams and girders. It is recognized of course, that this flange stress does not exist as uniform through the full length of a beam or girder flange, and is therefore properly entitled to somewhat higher unit stresses than the direct use of the column formula would permit. Practice over many years has established that it should be unnecessary to reduce the allowable stress in the compression flange until the length of this unsupported flange is more than 15 times its width. On this basis the 18,000 pound unit stress is permitted up to the point where l/b is 15, and is reduced by the column formula curve beyond this point. The constant in the denominator of this curve is determined as in the other two formulae by drawing a curve which starts at 20,000 and passes through 18,000 at 15 l/b.

The A. I. S. C. Specification has, in the treatment of this subject, eliminated a large part of the empirical formulae which have existed in the past. It might be advocated that a straight line formula would as satisfactorily answer the purpose, but it should be remembered that such a straight line formula does not contain any factor which can be interpreted as representing failure by flexure. In addition to this, the use of any formula depends upon the engineer having before him the tabulated properties of the sections to be used, and if this tabulation is necessary in the straight line formula, it would be just as consistent to carry the calculations one stage further and give the allowable unit stress, thus eliminating the chances of errors in calculation.

On the page opposite is given a chart for determining the per cent of the allowable uniform load which various compression flanges may carry if laterally unsupported. The maximum allowable load is that which produces a flange stress of 18000 pounds per square inch on the beam or girder when laterally supported. The formula is,

$$f_c = \frac{20000}{1 + \dfrac{l^2}{2000\, b^2}}$$

In which

fc = allowable compression stress in pounds per square inch:
l = unsupported length of the compression flange in inches.
b = width of the flange in inches.

The oblique lines pass through the flange width scale given in inches and zero.

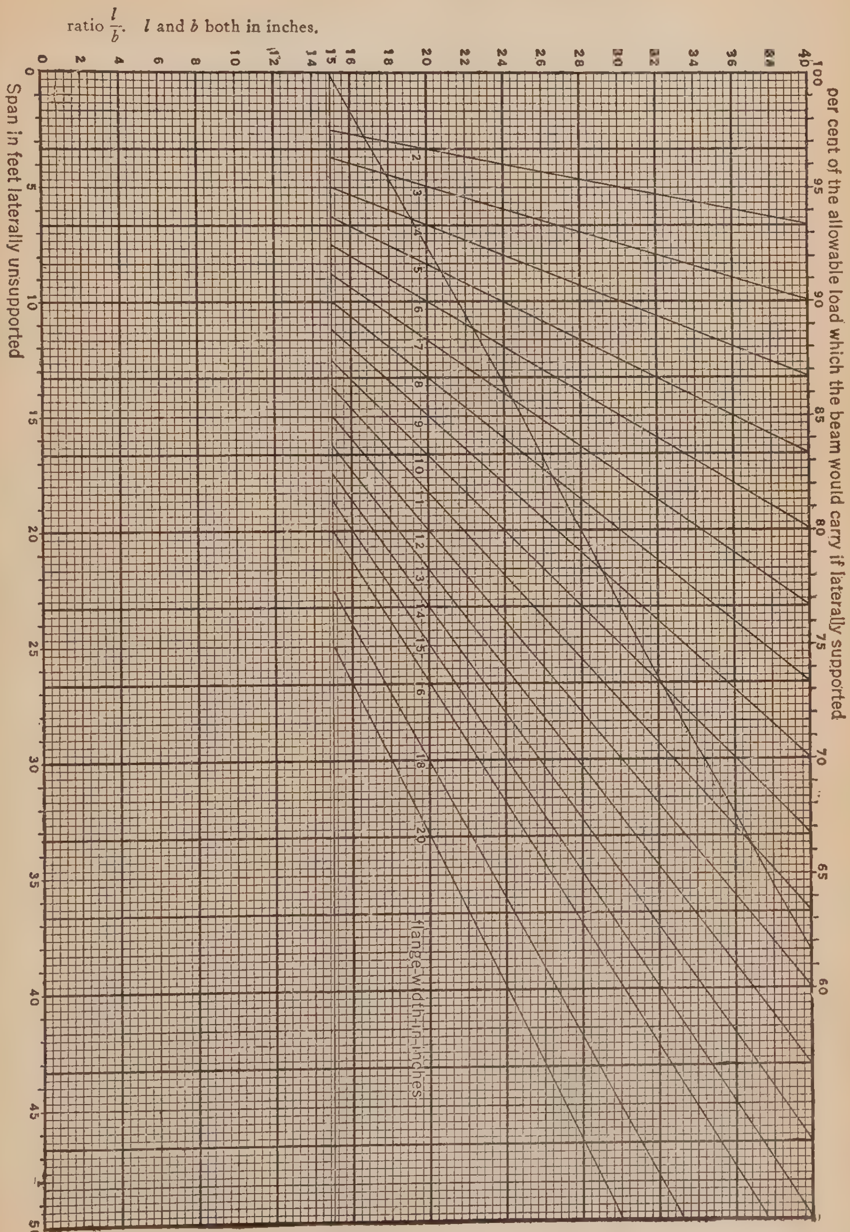
These lines intersect verticals from the span given in feet. The horizontal line from this intersection gives the ratio l/b on the left of the chart; and where this horizontal line crosses the percentage line, is the per cent of a laterally supported beam load which the same beam will carry if laterally unsupported.

Example:—

A flange 6 inches wide on a laterally unsupported span of 15 feet has l/b equal to 30, and it will carry 76½% of the load of the same beam if it is laterally supported. The chart also gives the spans where the reduction of flange stress is required, and the maximum spans for laterally unsupported flanges.

A table giving the allowable flange stress and percentage of fixed beam loads for beams with laterally unsupported flanges is given on the page immediately following the chart.

LATERALLY UNSUPPORTED FLANGES



BEAMS AND GIRDERS WITH LATERALLY UNSUPPORTED FLANGES

ALLOWABLE STRESS, IN POUNDS PER SQ. INCH, IN EXTREME FIBRE FOR VARIOUS RATIOS OF l/b

$\frac{l}{b}$	Fibre Stress	$\frac{l}{b}$	Fibre Stress	$\frac{l}{b}$	Fibre Stress	$\frac{l}{b}$	Fibre Stress	$\frac{l}{b}$	Fibre Stress
15.0	18000	20.0	16667	25.0	15238	30.0	13793	35.0	12403
16.0	17730	21.0	16387	26.0	14948	31.0	13509	36.0	12136
17.0	17475	22.0	16103	27.0	14657	32.0	13228	37.0	11873
18.0	17212	23.0	15817	28.0	14368	33.0	12949	38.0	11614
19.0	16942	24.0	15528	29.0	14080	34.0	12674	39.0	11360
								40.0	11111

PERCENTAGE OF FIXED BEAM LOADS FOR VARIOUS RATIOS OF l/b

$\frac{l}{b}$	%	$\frac{l}{b}$	%	$\frac{l}{b}$	%	$\frac{l}{b}$	%	$\frac{l}{b}$	%
15.0	100.00	20.0	92.58	25.0	84.65	30.0	76.63	35.0	68.90
15.1	99.74	20.1	92.43	25.1	84.49	30.1	76.47	35.1	68.76
15.2	99.61	20.2	92.28	25.2	84.33	30.2	76.31	35.2	68.61
15.3	99.47	20.3	92.13	25.3	84.17	30.3	76.15	35.3	68.46
15.4	99.33	20.4	91.97	25.4	84.01	30.4	75.99	35.4	68.31
15.5	99.19	20.5	91.82	25.5	83.85	30.5	75.84	35.5	68.16
15.6	99.06	20.6	91.66	25.6	83.69	30.6	75.68	35.6	68.01
15.7	98.93	20.7	91.50	25.7	83.53	30.7	75.52	35.7	67.86
15.8	98.78	20.8	91.35	25.8	83.37	30.8	75.36	35.8	67.72
15.9	98.64	20.9	91.19	25.9	83.20	30.9	75.21	35.9	67.57
16.0	98.50	21.0	91.04	26.0	83.04	31.0	75.05	36.0	67.42
16.1	98.36	21.1	90.88	26.1	82.88	31.1	74.89	36.1	67.27
16.2	98.22	21.2	90.72	26.2	82.72	31.2	74.74	36.2	67.13
16.3	98.08	21.3	90.56	26.3	82.55	31.3	74.58	36.3	66.98
16.4	97.94	21.4	90.41	26.4	82.39	31.4	74.42	36.4	66.83
16.5	97.80	21.5	90.25	26.5	82.23	31.5	74.26	36.5	66.69
16.6	97.65	21.6	90.09	26.6	82.07	31.6	74.11	36.6	66.54
16.7	97.51	21.7	89.93	26.7	81.91	31.7	73.95	36.7	66.39
16.8	97.37	21.8	89.78	26.8	81.75	31.8	73.79	36.8	66.25
16.9	97.23	21.9	89.62	26.9	81.59	31.9	73.64	36.9	66.11
17.0	97.08	22.0	89.46	27.0	81.43	32.0	73.48	37.0	65.96
17.1	96.94	22.1	89.30	27.1	81.27	32.1	73.33	37.1	65.82
17.2	96.80	22.2	89.14	27.2	81.11	32.2	73.17	37.2	65.67
17.3	96.65	22.3	88.98	27.3	80.94	32.3	73.02	37.3	65.53
17.4	96.50	22.4	88.82	27.4	80.78	32.4	72.86	37.4	65.38
17.5	96.35	22.5	88.66	27.5	80.62	32.5	72.71	37.5	65.24
17.6	96.21	22.6	88.51	27.6	80.46	32.6	72.55	37.6	65.09
17.7	96.06	22.7	88.35	27.7	80.30	32.7	72.40	37.7	64.95
17.8	95.92	22.8	88.19	27.8	80.14	32.8	72.25	37.8	64.81
17.9	95.77	22.9	88.03	27.9	79.98	32.9	72.09	37.9	64.67
18.0	95.62	23.0	87.87	28.0	79.82	33.0	71.94	38.0	64.52
18.1	95.47	23.1	87.71	28.1	79.66	33.1	71.78	38.1	64.38
18.2	95.33	23.2	87.55	28.2	79.50	33.2	71.63	38.2	64.24
18.3	95.17	23.3	87.39	28.3	79.34	33.3	71.48	38.3	64.09
18.4	95.02	23.4	87.23	28.4	79.18	33.4	71.32	38.4	63.96
18.5	94.87	23.5	87.07	28.5	79.02	33.5	71.17	38.5	63.81
18.6	94.72	23.6	86.91	28.6	78.86	33.6	71.02	38.6	63.67
18.7	94.57	23.7	86.75	28.7	78.69	33.7	70.87	38.7	63.53
18.8	94.43	23.8	86.59	28.8	78.53	33.8	70.72	38.8	63.39
18.9	94.27	23.9	86.43	28.9	78.38	33.9	70.56	38.9	63.25
19.0	94.12	24.0	86.27	29.0	78.22	34.0	70.41	39.0	63.11
19.1	93.97	24.1	86.11	29.1	78.06	34.1	70.26	39.1	62.97
19.2	93.82	24.2	85.94	29.2	77.90	34.2	70.11	39.2	62.83
19.3	93.66	24.3	85.78	29.3	77.74	34.3	69.96	39.3	62.69
19.4	93.51	24.4	85.62	29.4	77.58	34.4	69.80	39.4	62.55
19.5	93.36	24.5	85.46	29.5	77.42	34.5	69.65	39.5	62.42
19.6	93.20	24.6	85.30	29.6	77.26	34.6	69.50	39.6	62.27
19.7	93.05	24.7	85.14	29.7	77.10	34.7	69.35	39.7	62.14
19.8	92.90	24.8	84.98	29.8	76.94	34.8	69.21	39.8	62.00
19.9	92.75	24.9	84.81	29.9	76.78	34.9	69.05	40.0	61.72

l = the unsupported length, in inches, of the compression flange.

b = the width of the flange in inches.

COLUMNS—ALLOWABLE STRESSES

(A. I. S. C. Specification)

All parts of the structure shall be so proportioned that the sum of the maximum static stresses in pounds per sq. in. shall not exceed the following:—

Compression

Rolled Steel, on short lengths or where lateral deflection is prevented 18000

On gross section of columns . . . . $\dfrac{18000}{1 + \dfrac{l^2}{18000r^2}}$

with a maximum of 15000

In which l is the unsupported length of the column, and r is the corresponding least radius of gyration of the section, both in inches. For main compression members, the ratio l/r shall not exceed 120, and for bracing and other secondary members, 200.

COLUMNS

One of the apparent defects in most curves representing column failures is the lack of consideration of the fact that steel in compression fails by one of three processes depending upon the ratio of slenderness. These three types of failure may be described as bearing, transverse crippling and flexure. Bearing failures occur in short specimens which can hardly be classed as columns in the usual meaning of the term, since a failure by bearing is evidenced by a lateral flow of the metal. It is of course, true that the physical evidence of bearing exists in all columns to the extent that the specimen is shortened and the area is increased by the lateral flow of the metal. As the ratio of slenderness increases, the action of bearing merges into a combination of shear and bearing on a plane inclined to the axis of the column, and this combination will be referred to as transverse crippling, which corresponds very closely to what is considered shear in the web of a beam or girder. Pure shear rarely exists in construction.

When the ratio of slenderness is small, and the specimen very short, the angle of the plane on which transverse failure occurs, is nearly at right angles to the direction of the compression stress, and the dominant condition of failure is bearing. This condition exists up to where l/r is approximately 25. As the length increases, the angle of this plane of failure changes, the bearing stress decreases, and the shearing increases until the plane is 45° to the axis of stress, and at this point the intensity of shear is one-half the axial stress, or direct compression. Failure in columns does not occur on this 45° plane, but when the

angle between the axial stress and the plane is approximately 35° to 40°, and is the result of a combination of shear and bearing, referred to as crippling.

Professor Charles E. Greene in his book on Structural Mechanics (1897) analyzes conditions of transverse shear, and by experiment found that in granular material, such as cast iron, the angle of the plane of failure was about 35° to the axis. Due to the ductile properties of steel, complete fracture cannot be obtained in this type of failure. If failure by transverse crippling is sufficiently complete, the column folds up about the part where primary failure started instead of bowing from end to end as will occur when the failure is one of flexure. It may, however, occur that in the primary failure by crippling, the resulting eccentricity may cause the failure to merge into a flexural condition, and bow from end to end although the primary condition was one of crippling. This will explain why columns sometimes fail by flexure against the axis of their maximum strength in bending.

An examination of many column tests shows that failure by transverse crippling dominates until the ratio of slenderness l/r is about 80 and sometimes more than 100. If it were possible to eliminate eccentricity, including metallurgical and mechanical inequalities both as regards the straightness of the column, and the application of the load, all columns would fail at practically uniform stress by transverse crippling. The elimination of mechanical and metallurgical eccentricities being impossible in commercial practice, means that when such eccentricities become sufficient, the columns will not fail by crippling, but by flexure; and to be consistent the formula for this flexure type of failure must include a factor representing flexure.

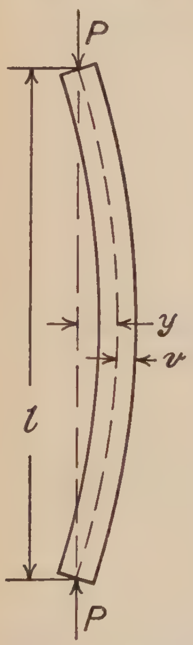
The American Institute of Steel Construction's Specification considers columns as resisting crippling (at 15,000 pounds per square inch), where l/r is 60 or less, and reduces the allowable working stress by a flexure formula where l/r is more than 60.

Confirming the uniformity with which columns fail under conditions of transverse crippling, the following records of test are given from which it will be seen that the strength corresponds to the yield point of the material.

Soft Steel 1″ Thick			Medium Steel 2″ Thick		
Length	l/r	Ultimate Stress per sq. in.	Length	l/r	Ultimate Stress per sq. in.
12′0″	40.5	38,700	12′0″	38	43,800
12′0″	40.5	38,000	12′0″	38	45,000
12′0″	40.5	37,700	12′0″	38	45,000
24′0″	81	38,600	24′0″	76	42,000
24′0″	81	37,600	24′0″	76	42,500
24′0″	81	36,600	24′0″	76	43,600

While the point at which failure by flexure due to metallurgical and mechanical eccentricity is empirical, and starts somewhere about where l/r is 80, the Specification is based on failures by transverse crippling ending where l/r is 60, and beyond this reduces the allowable stress by a flexure formula which prevents an appreciable increase in the unknown initial eccentricity.

Such a formula for determining the maximum working stress should be obtained by combining the stress per square inch due to direct compression, and the stress per square inch due to flexure, making the sum of these two equal the maximum allowable stress. In connection with the diagram attached hereto:



l = length of the column in inches.

y = maximum deflection in inches from the line of action of the compression stress.

v = distance in inches of the extreme fibre from the axis of the section through its center of gravity.

P = total load in compression.

A = area of the column in square inches.

I = moment of inertia of the column cross section $= Ar^2$

S = section modulus of the column $= \dfrac{I}{v} = \dfrac{Ar^2}{v}$,

r = radius of gyration of the column cross section.

f = maximum allowable stress intensity per square in.

The intensity of stress per square inch due to direct compression is then equal $\dfrac{P}{A}$.

The bending moment due to direct compression is P y.

The stress per sq. in. due to bending is $\dfrac{Py}{S} = \dfrac{Pyv}{Ar^2}$.

Then combining the stress per square inch from direct compression with the stress per square inch due to bending, we have,

$$f = \frac{P}{A} + \frac{Pyv}{Ar^2} = \frac{P}{A}\left(1 + \frac{yv}{r^2}\right)$$

and solving this, we have

$$\frac{P}{A} = \frac{f}{1 + \dfrac{yv}{r^2}}$$

$$\frac{P}{A} = \frac{f}{1 + \frac{yv}{r^2}}$$

This formula must be correct within the elastic limit of the material if our theory of flexure is sound. It cannot, however, be used in this form because y is unknown. It is, however, known that as l increases y will also increase. Also yv is a distance times a distance in which v is a constant. To retain the consistency of the equation in replacing the quantity yv, we must have it include a distance times a distance; and as l is the distance, regulating the variation in y, we may properly introduce cl^2 to replace the quantity yv. In this factor c includes the constant v, and the unknown ratio of l to y. Substituting the quantity cl^2, we have the Rankine formula.

$$\frac{P}{A} = \frac{f}{1 + \frac{cl^2}{r^2}}$$

This substitution above referred to is reasonable, for as v increases, other things being equal, y must decrease, and as l increases y must increase in a greater ratio. If the length of the column increases while the cross section and v remain the same, clearly y would increase in a greater ratio.

It may be said that this formula contains one inherent inaccuracy, namely, that c should really be a variable increasing with P. It is not practical to make c a variable for designing purposes, and furthermore, the exact law of its variation has not been determined. The purpose of reducing the working stress is to make the variation of c so small that it is negligible; it is therefore assumed a constant for practical purposes, and in this connection the use of the formula is limited for primary columns between the points 60 l/r and 120 l/r; and for secondary members from 120 l/r to 200 l/r. The determination of the constant in the denominator of this formula is as follows:

The maximum allowable stress in compression is 18000 pounds, and at 60 l/r the maximum allowable working stress has been fixed at 15000 lbs.

From this we derive the equation,

$$15000 = \frac{18000}{1 + \frac{cl^2}{r^2}}$$

Substituting 60 for l/r, we have

$$15000 = \frac{18000}{1 + 3600\,c}$$

Solving this, we have

$$c = \frac{1}{18000}$$

and our formula then becomes,

$$\frac{P}{A} = f = \frac{18000}{1 + \dfrac{l^2}{18000 r^2}}$$

This provides a reduction in stress per square inch over the range in which the column is considered as failing through flexure.

It might be advocated that a straight line formula could be devised to give practically the same reductions for flexural conditions as the curve, but a comparative analysis of the two shows that the straight line is mathematically inconsistent. The straight line formula is,

$$\frac{P}{A} = f - \frac{cl}{r} \text{ or } f = \frac{P}{A} + \frac{cl}{r}$$

In the development of our formula we found f equal to the sum of the direct load stress and the bending stress, or,

$$f = \frac{P}{A} + \frac{P\,y\,v}{Ar^2}$$

From these formulae we have,

$$\frac{Pyv}{Ar^2} = \frac{cl}{r}$$

In this we find that cl/r of the straight line formula is equal to the bending stress in our formula. This is not consistent, since on the left we have a stress per square inch times a ratio and on the right a constant times a ratio.

Furthermore, solving for y, we have,

$$y = \frac{clAr}{Pv}$$

In this we find that y would increase if either A or r were increased, which is the reverse of actual conditions; also if P were increased, y would decrease, which is absurd.

The claim that a straight line formula is easier to operate is based upon the assumption that the operator has memorized the tables of radius of gyration and if he has not, the tabulation might consistently be carried one step further giving the unit stress and eliminating the chances for errors in computation.

On the page opposite is a chart which is devised to eliminate the necessity of tedious mathematical calculations to determine the allowable working stress in columns of various lengths.

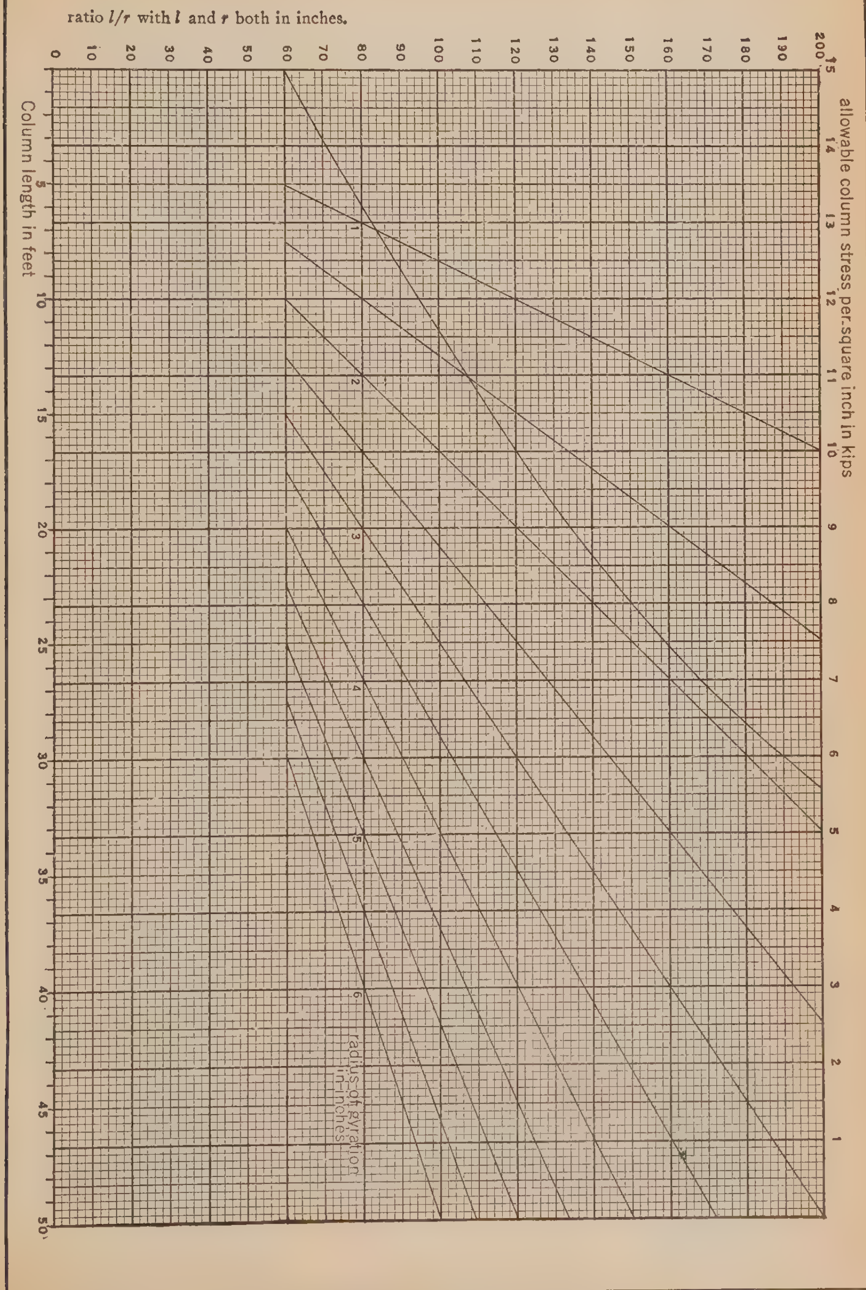
The oblique lines through the points on the scale of radius of gyration in inches all pass through zero. These lines intersect verticals from the base where the length of the column is shown in feet. The horizontal line at the point of this intersection gives the ratio of l/r on the left of the chart. The line which is the scale of radius of gyration in inches is so located that the length of the column in feet is converted to inches and divided by the radius of gyration which is read on its scale. Where the horizontal line from the ratio of l/r intersects the column formula curve, the allowable stress per square inch in the column is read at the top of the chart.

Example:—

The oblique line representing r equal to 3 inches crosses the vertical line representing a column 27 feet long at a horizontal line showing the ratio l/r to be 108. This horizontal line crosses the curve at a point which shows the stress to be 10,900 pounds per square inch.

A table giving the allowable working stress per square inch for ratios of l/r ranging from 60 to 200 is given on the page immediately following the chart.

COLUMNS


ratio l/r with l and r both in inches.
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Column length in feet
5 10 15 20 25 30 35 40 45 50
allowable column stress per square inch in kips
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
1 2 3 4 5 6
radius of gyration in inches

ALLOWABLE WORKING STRESS FOR COLUMNS. VARIOUS RATIOS l/r

PRIMARY MEMBERS

l/r	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
.0	15000	14916	14832	14748	14663	14578	14493	14407	14321	14235	14148	14062	13975	13888	13801	13714	13627	13540	13453	13366
.1	14992	14908	14824	14740	14655	14570	14484	14398	14312	14226	14139	14053	13966	13879	13792	13705	13618	13531	13444	13357
.2	14983	14899	14815	14731	14646	14561	14476	14390	14304	14218	14131	14045	13958	13871	13784	13697	13610	13523	13436	13349
.3	14974	14891	14807	14723	14638	14553	14467	14381	14295	14209	14122	14036	13949	13862	13775	13688	13601	13514	13427	13340
.4	14966	14882	14798	14714	14629	14544	14459	14373	14287	14200	14114	14027	13940	13853	13766	13679	13592	13505	13418	13331
.5	14958	14874	14790	14706	14621	14536	14450	14364	14278	14192	14105	14019	13932	13845	13758	13671	13584	13497	13410	13323
.6	14950	14866	14782	14697	14612	14527	14441	14355	14269	14183	14096	14010	13923	13836	13749	13662	13575	13488	13401	13314
.7	14941	14857	14773	14689	14604	14519	14433	14347	14261	14174	14088	14001	13914	13827	13740	13653	13566	13479	13392	13305
.8	14933	14849	14765	14680	14595	14510	14424	14338	14252	14165	14079	13992	13905	13818	13731	13644	13557	13470	13383	13296
.9	14924	14840	14756	14672	14587	14502	14416	14330	14244	14157	14071	13984	13897	13810	13723	13636	13549	13462	13375	13288
l/r	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
.0	13279	13192	13105	13018	12931	12844	12758	12672	12585	12500	12414	12328	12243	12158	12073	11989	11905	11821	11737	11654
.1	13270	13183	13096	13009	12922	12835	12749	12663	12577	12491	12405	12320	12235	12150	12065	11981	11897	11813	11729	11646
.2	13262	13175	13088	13001	12914	12827	12741	12655	12568	12483	12397	12311	12226	12141	12056	11972	11888	11804	11720	11637
.3	13253	13166	13079	12992	12905	12818	12732	12646	12560	12474	12388	12303	12218	12133	12048	11964	11880	11796	11712	11629
.4	13244	13157	13070	12983	12896	12810	12724	12637	12551	12466	12380	12294	12209	12124	12039	11955	11871	11787	11704	11621
.5	13236	13149	13062	12975	12888	12801	12715	12629	12543	12457	12371	12286	12201	12116	12031	11947	11863	11779	11696	11613
.6	13227	13140	13053	12966	12879	12792	12706	12620	12534	12448	12362	12277	12192	12107	12023	11939	11855	11771	11687	11604
.7	13218	13131	13044	12957	12870	12784	12698	12611	12526	12440	12354	12269	12184	12099	12014	11930	11846	11762	11679	11596
.8	13209	13122	13035	12948	12861	12775	12689	12602	12517	12431	12345	12260	12175	12090	12006	11922	11838	11754	11671	11588
.9	13201	13114	13027	12940	12853	12767	12681	12594	12509	12423	12337	12252	12167	12082	11997	11913	11829	11745	11662	11579
l/r	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
.0	11571	11489	11407	11325	11244	11163	11082	11002	10922	10843	10764	10686	10608	10530	10453	10376	10300	10224	10149	10074
.1	11563	11481	11399	11317	11236	11155	11074	10994	10914	10835	10756	10678	10600	10522	10445	10368	10292	10217	10142	10067
.2	11555	11473	11391	11309	11228	11147	11066	10986	10906	10827	10748	10670	10592	10515	10438	10361	10285	10209	10134	10059
.3	11546	11464	11382	11301	11220	11139	11058	10978	10898	10819	10741	10663	10585	10507	10430	10353	10277	10202	10127	10052
.4	11538	11456	11374	11293	11212	11131	11050	10970	10890	10811	10733	10655	10577	10499	10422	10346	10270	10194	10119	10044
.5	11530	11448	11366	11285	11204	11123	11042	10962	10883	10804	10725	10647	10569	10492	10415	10338	10262	10187	10112	10037
.6	11522	11440	11358	11276	11195	11114	11034	10954	10875	10796	10717	10639	10561	10484	10407	10330	10254	10179	10104	10030
.7	11514	11432	11350	11268	11187	11106	11026	10946	10867	10788	10709	10631	10553	10476	10399	10323	10247	10172	10097	10022
.8	11505	11423	11341	11260	11179	11098	11018	10938	10859	10780	10702	10624	10546	10468	10391	10315	10239	10164	10089	10015
.9	11497	11415	11333	11252	11171	11090	11010	10930	10851	10772	10694	10616	10538	10461	10384	10308	10232	10157	10082	10007

SECONDARY MEMBERS ONLY

l/r	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
.0	10000	9926	9853	9780	9708	9636	9565	9494	9424	9354	9284	9215	9146	9078	9011	8944	8878	8812	8747	8682
.5	9963	9890	9817	9744	9672	9601	9530	9459	9389	9319	9250	9181	9112	9045	8978	8911	8845	8780	8715	8650
l/r	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
.0	8617	8553	8489	8426	8364	8302	8241	8180	8120	8060	8000	7941	7882	7824	7767	7710	7653	7597	7541	7486
.5	8585	8521	8458	8395	8333	8272	8211	8150	8090	8030	7971	7912	7853	7796	7739	7682	7625	7569	7514	7459
l/r	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
.0	7431	7377	7323	7270	7217	7164	7112	7060	7009	6958	6908	6858	6808	6759	6711	6663	6615	6568	6521	6475
.5	7404	7350	7297	7244	7191	7138	7086	7034	6984	6933	6883	6833	6784	6735	6687	6639	6592	6545	6498	6452
l/r	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199
.0	6429	6383	6338	6293	6248	6204	6160	6117	6074	6031	5989	5947	5905	5864	5823	5783	5743	5703	5664	5625
.5	6406	6361	6316	6271	6226	6182	6139	6096	6053	6010	5968	5926	5885	5844	5803	5763	5723	5684	5645	5606

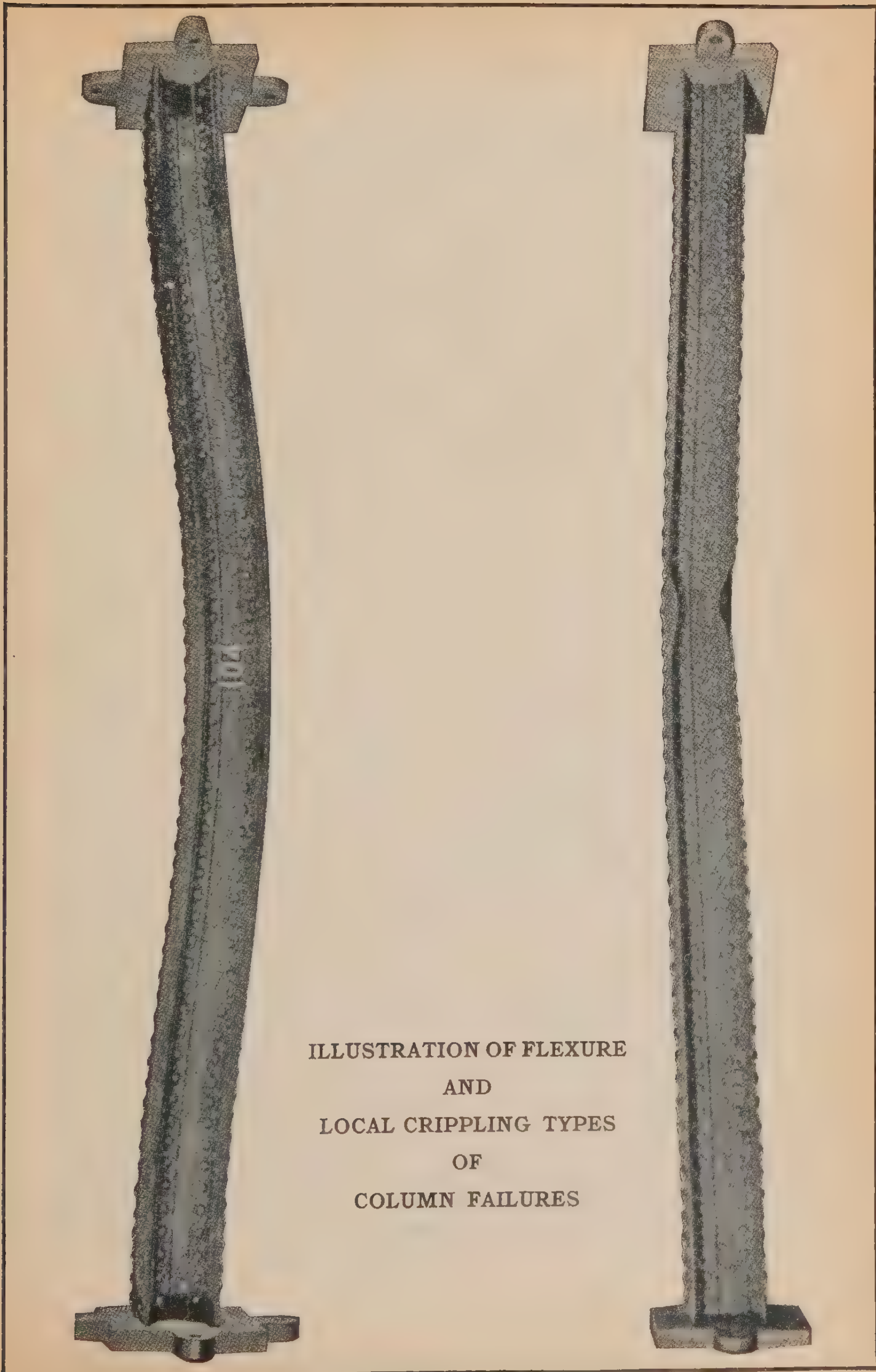
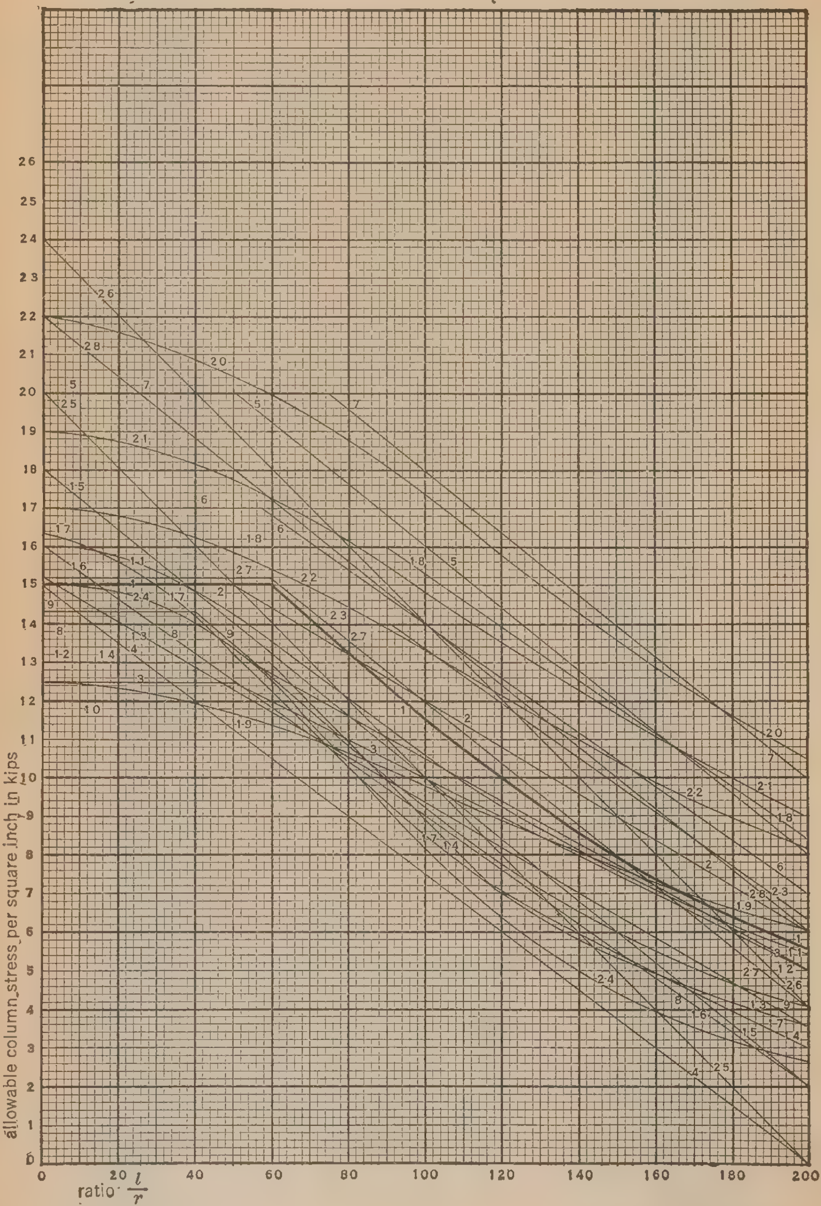


ILLUSTRATION OF FLEXURE
AND
LOCAL CRIPPLING TYPES
OF
COLUMN FAILURES

COLUMN DIAGRAMS



COLUMN DIAGRAMS

On the page opposite there is a diagram illustrating twenty-eight (28) different column formulae, including that of the American Institute of Steel Construction which is shown as the heavy line.

Since the rolling mills began publishing handbooks about thirty-five years ago based on a 16,000 pound unit stress, an endless number of column formulae have been devised to give the allowable working stresses under different ratios of slenderness.

The diagrams clearly illustrate that the basic unit stress is not a consistent index of the so called factor of safety.

Below is given a key to the chart with the various formulae which are represented.

1. A. I. S. C.: 15000 to 60 l/r: beyond 60 $l/r = \dfrac{18{,}000}{1 + \dfrac{l^2}{18{,}000r^2}}$
2. Am. Bridge 1922: 18000— 60 l/r with max. 15000
3. A. R. E. A. design Ry. Bridge: 15000—50 l/r with max. 12500
4. A. R. E. A. electrical spec.: 15000—75 l/r
5. A. R. E. A. existing Ry. Bridge O. H. Steel: 24000—80 l/r with max. 20000
6. A. R. E. A. existing Ry. Bridge Besm. Steel: 21000—70 l/r with max. 17000
7. A. R. E. A. existing Buildings: 26000 — 80 l/r with max. 20000
8. A. R. E. A. 1920 Ry. Bridges: 16000—70 l/r with max. 14000
9. A. S. C. E. Highway Bridge: $\dfrac{16{,}000}{1 + \dfrac{l^2}{13{,}500r^2}}$ with max. at 40 l/r
10. Boston 1919: 12000 to 80 l/r: 20000—100 l/r above 80 l/r
11. Boston 1918: $\dfrac{16{,}000}{1 + \dfrac{l^2}{20{,}000r^2}}$
12. Bethlehem Steel: 16000—55 l/r with max. 13000
13. N. Y. City: 15200—58 l/r prior to 1915. 16000—70 l/r
14. Carnegie straight lines: 13000 to 50 l/r: 7000 at 120 l/r: 3000 at 200 l/r

    J. & L. Chicago etc. use No. 8
15. Omaha: 18000—80 l/r
16. N. Y. C. Ry.: 16000—70 l/r with max. 15000

    Can. Eng. Std. Assn. Ry. Bridges—Use No. 3
17. Philadelphia: $\dfrac{16{,}000}{1 + \dfrac{l^2}{11{,}000r^2}}$
18. Canton Boiler: 16000 to 90 l/r above which 21400—60 l/r

19. **Cambria-Gordon:** $\dfrac{12{,}500}{1+\dfrac{l^2}{36{,}000r^2}}$

20. **Osborn Highway:** $\dfrac{22{,}000}{1+\dfrac{l^2}{36{,}000r^2}}$

21. **Osborn Elect. Ry.:** $\dfrac{19{,}000}{1+\dfrac{l^2}{36{,}000r^2}}$

22. **Osborn Steam Ry.:** $\dfrac{17{,}000}{1+\dfrac{l^2}{36{,}000r^2}}$

23. Chicago Bridge & Iron: 20300—70 l/r: max. 14000

24. Cleveland: $S=\dfrac{P}{A}\left[1+\left(\dfrac{ec}{r^2}+\dfrac{3}{10}\right)\text{Sec.}\ \dfrac{l}{Kr}\sqrt{\dfrac{FP}{AE}}\right]$

25. Blackwells Island Bridge Ordinary loading: 20000—100 l/r

26. Blackwells Island Bridge Congested loading: 24000—100 l/r

27. Present Quebec Bridge combined loads exclusive of secondary stresses: 20000—80 l/r with max. 15200

28. Present Quebec Bridge All combined loads inclusive of secondary stresses: 22000—80 l/r.

RIVETS AND BOLTS

For many years there has been a considerable variation in the working stresses allowed in rivets, and careful thought was given this important subject. Engineers have long recognized that more complete conditions of bearing exist on plates and sections, which are enclosed on both sides, than can exist on outside plates or sections where the rivet acts as a cantilever. Rational provision is made for this in our Specification and it will permit a more consistent and economical development of stresses. Tests which have been recently made clearly indicate the truth of what many engineers have believed regarding the friction between riveted surfaces being greater than the usually allowed working stress in the rivets.

The Specification also properly classifies rivets as power or hand driven instead of field or shop driven.

Power driven rivets are those driven by pneumatic tools, whether in the shop or field. Hand driven rivets are those driven without the use of pneumatic equipment.

CONNECTION ANGLES

The use of the Standard Web Connection Angle for supporting the end reactions of beams and girders is based on the assumption that the beam or girder has been proportioned, and will act as a simple beam. If uniformly loaded a simple beam has its maximum bending moment and deflection at the center of the span.

The deflection curve for a simple beam is a parabola, and where it supports a plastered ceiling the maximum deflection due to live load is limited to 1/360 of the span. If the beam were considered as fixed at its ends, the maximum bending moment is at the end of the beam, and this moment will be 50% greater than the center moment. It is obviously impossible to consider a pair of web connection angles capable of changing a simple span beam to one with fixed ends. Where there is a deflection of 1/360 of the span due to uniform loading, the ends of the beam will no longer be perpendicular to the original axis of the beam, but will move through an angle of about 0° 38′, causing bending in the outstanding legs of the connection angles between the rivets and the heel of the angles. This movement in the outstanding legs of the angles will be the same for all thicknesses of angles so long as the beam acts as a simple span, and the unit stress resulting from this bending in the angles will be proportional to the section modulus of the material which is bent. The section modulus of the material bent is proportional to the square of its thickness. That is, the relative unit stresses in angles ⅜″ thick and ½″ thick is as 9 is to 16, and the unit stress in a ½″ angle is 1.78 times the unit stress in a ⅜″ angle.

The proper thickness for connection angles is therefore the minimum which will develop the bearing value of the rivets used in shear. For ¾″ power driven rivets this thickness is between 5/16″ and ⅜″, and the ⅜″ thickness is therefore used.

It has been the standard of the industry to keep the center to center distance between rivets in the outstanding angle legs 5½″ by varying the gage in the outstanding legs of the angles to offset the different thickness of beam webs. This variation in the outstanding leg gage is by sixteenths of an inch, which is so inconspicuous in angles with equal legs that in shop assembling the web leg and the outstanding leg are often interchanged unless extreme care is used, resulting in errors which are expensive to correct in the field. To obviate this and speed up shop assembling, the standard connection is made 4″ × 3½″ × ⅜″ with the 3½″ leg and a 2¼″ gage always on the beam web. The 2¼″ gage in the leg against the web is sufficient to permit ignoring the allowable cutting tolerance of ⅜″ over or under the ordered length of the beam.

The 4″ × 3½″ × ⅜″ is a more desirable angle for stock as it is more adaptable to other uses than the 4″ × 4″ × ½″ angle previously used.

NOTES and DIAGRAMS

Part IV
Section 2

Angles

Dimensions and Technical Functions

Tensile Values

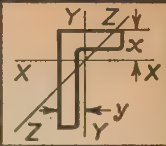
Allowable Total Loads
by
A. I. S. C. Specification
for
One Angle Struts

Two Angle Struts

Angles used as Beams

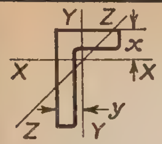
STANDARD ANGLES

SIZES
WEIGHTS — AREAS
TECHNICAL FUNCTIONS



Size in Inches	Thickness	Weight per Foot	Area in Sq. In.	AXES X - X I	X - X S	X - X r	X - X x	Y - Y I	Y - Y S	Y - Y r	Y - Y y	Z - Z r
★ 1¾ × 1¾	1/8	1.44	0.42	0.13	0.10	0.55	0.48	....	....	....	....	0.35
	3/16	2.12	0.62	0.18	0.14	0.54	0.51	....	....	....	....	0.34
	1/4	2.77	0.81	0.23	0.19	0.53	0.53	....	....	....	....	0.34
★ 2 × 2	1/8	1.65	0.48	0.19	0.13	0.63	0.55	....	....	....	....	0.40
	3/16	2.44	0.72	0.27	0.19	0.62	0.57	....	....	....	....	0.39
	1/4	3.19	0.94	0.35	0.25	0.61	0.59	....	....	....	....	0.39
	5/16	3.92	1.15	0.42	0.30	0.60	0.61	....	....	....	....	0.39
★ 2½ × 2	1/8	1.86	0.55	0.35	0.20	0.80	0.74	0.20	0.13	0.61	0.49	0.43
	3/16	2.75	0.81	0.51	0.29	0.79	0.76	0.29	0.20	0.60	0.51	0.43
	1/4	3.62	1.06	0.65	0.38	0.78	0.79	0.37	0.25	0.59	0.54	0.42
	5/16	4.50	1.31	0.79	0.47	0.78	0.81	0.45	0.31	0.58	0.56	0.42
★ 2½ × 2½	1/8	2.08	0.61	0.38	0.20	0.79	0.67	....	....	....	....	0.50
	3/16	3.07	0.90	0.55	0.30	0.78	0.69	....	....	....	....	0.49
	1/4	4.1	1.19	0.70	0.39	0.77	0.72	....	....	....	....	0.49
	5/16	5.0	1.47	0.85	0.48	0.76	0.74	....	....	....	....	0.49
	3/8	5.9	1.73	0.98	0.57	0.75	0.76	....	....	....	....	0.48
3 × 2½	1/4	4.5	1.31	1.17	0.56	0.95	0.91	0.74	0.40	0.75	0.66	0.53
	5/16	5.6	1.62	1.42	0.69	0.94	0.93	0.90	0.49	0.74	0.68	0.53
	3/8	6.6	1.92	1.66	0.81	0.93	0.96	1.04	0.58	0.74	0.71	0.52
	7/16	7.6	2.22	1.88	0.93	0.92	0.98	1.18	0.66	0.73	0.73	0.52
3 × 3	1/4	4.9	1.44	1.24	0.58	0.93	0.84	....	....	....	....	0.59
	5/16	6.1	1.78	1.51	0.71	0.92	0.87	....	....	....	....	0.59
	3/8	7.2	2.11	1.76	0.83	0.91	0.89	....	....	....	....	0.58
	7/16	8.3	2.43	1.99	0.95	0.91	0.91	....	....	....	....	0.58
	1/2	9.4	2.75	2.22	1.07	0.90	0.93	....	....	....	....	0.58
3½ × 2½	1/4	4.9	1.44	1.80	0.75	1.12	1.11	0.78	0.41	0.74	0.61	0.54
	5/16	6.1	1.78	2.19	0.93	1.11	1.14	0.94	0.50	0.73	0.64	0.54
	3/8	7.2	2.11	2.56	1.09	1.10	1.16	1.09	0.59	0.72	0.66	0.54
	7/16	8.3	2.43	2.91	1.26	1.09	1.18	1.23	0.68	0.71	0.68	0.54
	1/2	9.4	2.75	3.24	1.41	1.09	1.20	1.36	0.76	0.70	0.70	0.53
3½ × 3½	5/16	7.2	2.09	2.45	0.98	1.08	0.99	....	....	....	....	0.69
	3/8	8.5	2.48	2.87	1.15	1.07	1.01	....	....	....	....	0.68
	7/16	9.8	2.87	3.26	1.32	1.07	1.04	....	....	....	....	0.68
	1/2	11.1	3.25	3.64	1.49	1.06	1.06	....	....	....	....	0.68
	9/16	12.4	3.62	3.99	1.65	1.05	1.08	....	....	....	....	0.68
	5/8	13.6	3.98	4.33	1.81	1.04	1.10	....	....	....	....	0.68
4 × 3	5/16	7.2	2.09	3.38	1.23	1.27	1.26	1.65	0.73	0.89	0.76	0.65
	3/8	8.5	2.48	3.96	1.46	1.26	1.28	1.92	0.87	0.88	0.78	0.64
	7/16	9.8	2.87	4.52	1.68	1.25	1.30	2.18	0.99	0.87	0.80	0.64
	1/2	11.1	3.25	5.05	1.89	1.25	1.33	2.42	1.12	0.86	0.83	0.64
	9/16	12.4	3.62	5.55	2.09	1.24	1.35	2.66	1.23	0.86	0.85	0.64
	5/8	13.6	3.98	6.03	2.30	1.23	1.37	2.87	1.35	0.85	0.87	0.64
4 × 3½	5/16	7.7	2.25	3.56	1.26	1.26	1.18	2.55	0.99	1.07	0.93	0.73
	3/8	9.1	2.67	4.18	1.49	1.25	1.21	2.99	1.17	1.06	0.96	0.73
	7/16	10.6	3.09	4.76	1.72	1.24	1.23	3.40	1.35	1.05	0.98	0.72
	1/2	11.9	3.50	5.32	1.94	1.23	1.25	3.79	1.52	1.04	1.00	0.72
	9/16	13.3	3.90	5.86	2.15	1.23	1.27	4.17	1.68	1.03	1.02	0.72
	5/8	14.7	4.30	6.37	2.35	1.22	1.29	4.49	1.83	1.02	1.04	0.72
	11/16	16.0	4.68	6.86	2.56	1.21	1.32	4.86	2.00	1.02	1.07	0.72
	3/4	17.3	5.06	7.32	2.75	1.20	1.34	5.18	2.15	1.01	1.09	0.72
4 × 4	5/16	8.2	2.40	3.71	1.29	1.24	1.12	....	....	....	....	0.79
	3/8	9.8	2.86	4.36	1.52	1.23	1.14	....	....	....	....	0.79
	7/16	11.3	3.31	4.97	1.75	1.23	1.16	....	....	....	....	0.78
	1/2	12.8	3.75	5.56	1.97	1.22	1.18	....	....	....	....	0.78
	9/16	14.3	4.18	6.12	2.19	1.21	1.21	....	....	....	....	0.78
	5/8	15.7	4.61	6.66	2.40	1.20	1.23	....	....	....	....	0.77
	11/16	17.1	5.03	7.17	2.61	1.19	1.25	....	....	....	....	0.77
	3/4	18.5	5.44	7.66	2.81	1.19	1.27	....	....	....	....	0.77
5 × 3	5/16	8.2	2.40	6.26	1.89	1.61	1.68	1.75	0.75	0.85	0.68	0.66
	3/8	9.8	2.86	7.37	2.24	1.61	1.70	2.04	0.89	0.84	0.70	0.65
	7/16	11.3	3.31	8.43	2.58	1.60	1.73	2.32	1.02	0.84	0.73	0.65
	1/2	12.8	3.75	9.45	2.91	1.59	1.75	2.58	1.15	0.83	0.75	0.65
	9/16	14.3	4.18	10.43	3.23	1.58	1.77	2.83	1.27	0.82	0.77	0.65
	5/8	15.7	4.61	11.37	3.55	1.57	1.80	3.06	1.39	0.82	0.80	0.64
	11/16	17.1	5.03	12.28	3.86	1.56	1.82	3.29	1.51	0.81	0.82	0.64
	3/4	18.5	5.44	13.15	4.16	1.55	1.84	3.51	1.62	0.80	0.84	0.64

★ Angles are classified as in BAR SIZE when their greatest dimension is less than 3 inches.



STANDARD ANGLES

SIZES

WEIGHTS — AREAS

TECHNICAL FUNCTIONS

Size in Inches	Thickness	Weight per Foot	Area in Sq. In.	AXES X-X I	X-X S	X-X r	X-X x	Y-Y I	Y-Y S	Y-Y r	Y-Y y	Z-Z r
5 × 3½	5/16	8.7	2.56	6.60	1.94	1.61	1.59	2.72	1.02	1.03	0.84	0.77
	3/8	10.4	3.05	7.78	2.29	1.60	1.61	3.18	1.21	1.02	0.86	0.76
	7/16	12.0	3.53	8.90	2.64	1.59	1.63	3.63	1.39	1.01	0.88	0.76
	1/2	13.6	4.00	9.99	2.99	1.58	1.66	4.05	1.56	1.01	0.91	0.75
	9/16	15.2	4.47	11.03	3.32	1.57	1.68	4.45	1.73	1.00	0.93	0.75
	5/8	16.8	4.92	12.03	3.65	1.56	1.70	4.83	1.90	0.99	0.95	0.75
	11/16	18.3	5.37	12.99	3.97	1.56	1.72	5.20	2.06	0.98	0.97	0.75
	3/4	19.8	5.81	13.92	4.28	1.55	1.75	5.55	2.22	0.98	1.00	0.75
6 × 3½	3/8	11.7	3.42	12.86	3.24	1.94	2.04	3.34	1.23	0.99	0.79	0.77
	7/16	13.5	3.97	14.76	3.75	1.93	2.06	3.81	1.41	0.98	0.81	0.76
	1/2	15.3	4.50	16.59	4.24	1.92	2.08	4.25	1.59	0.97	0.83	0.76
	9/16	17.1	5.03	18.37	4.72	1.91	2.11	4.67	1.77	0.96	0.86	0.75
	5/8	18.9	5.55	20.08	5.19	1.90	2.13	5.08	1.94	0.96	0.88	0.75
	11/16	20.6	6.06	21.74	5.65	1.89	2.15	5.47	2.11	0.95	0.90	0.75
	3/4	22.4	6.56	23.34	6.10	1.89	2.18	5.84	2.27	0.94	0.93	0.75
	13/16	24.0	7.06	24.89	6.55	1.88	2.20	6.20	2.43	0.94	0.95	0.75
	7/8	25.7	7.55	26.39	6.98	1.87	2.22	6.55	2.59	0.93	0.97	0.75
6 × 4	3/8	12.3	3.61	13.47	3.32	1.93	1.94	4.90	1.60	1.17	0.94	0.88
	7/16	14.3	4.18	15.46	3.83	1.92	1.96	5.60	1.85	1.16	0.96	0.87
	1/2	16.2	4.75	17.40	4.33	1.91	1.99	6.27	2.08	1.15	0.99	0.87
	9/16	18.1	5.31	19.26	4.83	1.90	2.01	6.91	2.31	1.14	1.01	0.87
	5/8	20.0	5.86	21.07	5.31	1.90	2.03	7.52	2.54	1.13	1.03	0.86
	11/16	21.8	6.40	22.82	5.78	1.89	2.06	8.11	2.76	1.13	1.06	0.86
	3/4	23.6	6.94	24.59	6.25	1.88	2.08	8.68	2.97	1.12	1.08	0.86
	13/16	25.4	7.47	26.15	6.70	1.87	2.10	9.23	3.18	1.11	1.10	0.86
	7/8	27.2	7.98	27.73	7.15	1.86	2.12	9.75	3.39	1.11	1.12	0.86
6 × 6	3/8	14.9	4.36	15.39	3.53	1.88	1.64	....	....	....	....	1.19
	7/16	17.2	5.06	17.68	4.07	1.87	1.66	....	....	....	....	1.19
	1/2	19.6	5.75	19.91	4.61	1.86	1.68	....	....	....	....	1.18
	9/16	21.9	6.43	22.07	5.14	1.85	1.71	....	....	....	....	1.18
	5/8	24.2	7.11	24.16	5.66	1.84	1.73	....	....	....	....	1.17
	11/16	26.5	7.78	26.19	6.17	1.83	1.75	....	....	....	....	1.17
	3/4	28.7	8.44	28.15	6.66	1.83	1.78	....	....	....	....	1.17
	13/16	31.0	9.09	30.06	7.15	1.82	1.80	....	....	....	....	1.17
	7/8	33.1	9.73	31.92	7.63	1.81	1.82	....	....	....	....	1.16
	15/16	35.3	10.37	33.72	8.11	1.80	1.84	....	....	....	....	1.16
	1	37.4	11.00	35.46	8.57	1.80	1.86	....	....	....	....	1.16
7 × 3½	3/8	13.0	3.80	19.62	4.34	2.27	2.48	3.47	1.25	0.96	0.73	0.76
	7/16	15.0	4.40	22.56	5.01	2.26	2.50	3.95	1.44	0.95	0.75	0.76
	1/2	17.0	5.00	25.41	5.68	2.25	2.53	4.41	1.62	0.94	0.78	0.75
	9/16	19.1	5.59	28.18	6.34	2.25	2.55	4.86	1.80	0.93	0.80	0.75
	5/8	21.0	6.17	30.86	6.96	2.24	2.57	5.28	1.97	0.93	0.82	0.75
	11/16	23.0	6.75	33.47	7.60	2.23	2.60	5.69	2.14	0.92	0.85	0.74
	3/4	24.9	7.31	35.99	8.22	2.22	2.62	6.08	2.31	0.91	0.87	0.74
	13/16	26.8	7.87	38.45	8.83	2.21	2.64	6.46	2.48	0.91	0.89	0.74
	7/8	28.7	8.42	40.82	9.42	2.20	2.66	6.83	2.64	0.90	0.91	0.74
	15/16	30.5	8.97	43.13	10.00	2.19	2.69	7.18	2.80	0.89	0.94	0.74
	1	32.3	9.50	45.37	10.58	2.19	2.71	7.53	2.96	0.89	0.96	0.74
8 × 6	7/16	20.2	5.93	39.23	7.07	2.57	2.45	19.25	4.23	1.80	1.45	1.30
	1/2	23.0	6.75	44.31	8.02	2.56	2.47	21.68	4.79	1.79	1.47	1.30
	9/16	25.7	7.56	49.26	8.95	2.55	2.50	24.04	5.34	1.78	1.50	1.30
	5/8	28.5	8.36	54.10	9.87	2.54	2.52	26.33	5.88	1.77	1.52	1.29
	11/16	31.2	9.15	58.82	10.77	2.54	2.54	28.56	6.40	1.77	1.54	1.29
	3/4	33.8	9.94	63.42	11.67	2.53	2.56	30.72	6.92	1.76	1.56	1.28
	13/16	36.5	10.72	67.92	12.55	2.52	2.59	32.82	7.44	1.75	1.59	1.28
	7/8	39.1	11.48	72.32	13.41	2.51	2.61	34.86	7.94	1.74	1.61	1.28
	15/16	41.7	12.25	76.59	14.27	2.50	2.63	36.85	8.43	1.73	1.63	1.28
	1	44.2	13.00	80.78	15.11	2.49	2.65	38.78	8.92	1.73	1.65	1.28
8 × 8	1/2	26.4	7.75	48.65	8.37	2.51	2.19	....	....	....	....	1.59
	9/16	29.6	8.68	54.09	9.34	2.50	2.21	....	....	....	....	1.58
	5/8	32.7	9.61	59.43	10.30	2.49	2.23	....	....	....	....	1.58
	11/16	35.8	10.53	64.64	11.25	2.48	2.25	....	....	....	....	1.58
	3/4	38.9	11.44	69.74	12.18	2.47	2.28	....	....	....	....	1.57
	13/16	42.0	12.34	74.72	13.11	2.46	2.30	....	....	....	....	1.57
	7/8	45.0	13.23	79.58	14.02	2.45	2.32	....	....	....	....	1.56
	15/16	48.1	14.12	84.34	14.91	2.44	2.34	....	....	....	....	1.56
	1	51.0	15.00	88.98	15.80	2.44	2.37	....	....	....	....	1.56
	1 1/16	54.0	15.87	93.53	16.67	2.43	2.39	....	....	....	....	1.56
	1 1/8	56.9	16.73	97.97	17.53	2.42	2.41	....	....	....	....	1.55

STANDARD ANGLES

NET AREAS AND TENSILE VALUES OF ONE ANGLE IN KIPS

TENSION AT 18000 POUNDS PER SQUARE INCH

TO DEVELOP VALUES BELOW, ANGLES MUST BE ATTACHED BY BOTH LEGS

Size in Inches	Thickness	½″ RIVET		⅝″ RIVET		¾″ RIVET				⅞″ RIVET			
		1 HOLE OUT		1 HOLE OUT		1 HOLE OUT		2 HOLES OUT		1 HOLE OUT		2 HOLES OUT	
		Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value
★ 1¾ × 1¾	1/8	.342	6.16										
	3/16	.503	9.05										
	1/4	.654	11.77										
★ 2 × 2	1/8	.402	7.24	.386	6.95								
	3/16	.593	10.67	.569	10.24								
	1/4	.784	14.11	.752	13.54								
	5/16	.955	17.19	.916	16.49								
★ 2½ × 2	1/8	.472	8.50	.456	8.21								
	3/16	.693	12.47	.669	12.04	.646	11.63						
	1/4	.904	16.27	.872	15.70	.841	15.14						
	5/16	1.115	20.07	1.076	19.37	1.037	18.66						
★ 2½ × 2½	1/8	.532	9.58	.516	9.29								
	3/16	.783	14.09	.759	13.66	.736	13.25	.572	10.30				
	1/4	1.034	18.61	1.002	18.04	.971	17.48	.752	13.54				
	5/16	1.275	22.95	1.236	22.25	1.197	21.55	.924	16.63				
	3/8	1.496	26.93	1.448	26.06	1.402	25.24	1.074	19.33				
3 × 2½	1/4	1.154	20.77	1.122	20.29	1.091	19.64	.872	15.70				
	5/16	1.425	25.65	1.386	24.95	1.347	24.25	1.074	19.33				
	3/8	1.686	30.35	1.638	29.48	1.592	28.66	1.264	22.75				
	7/16	1.937	34.87	1.882	33.88	1.827	32.89	1.444	25.99				
3 × 3	1/4	.....	.....	1.252	22.54	1.221	21.98	1.002	18.04				
	5/16	.....	.....	1.546	27.83	1.507	27.13	1.234	22.21				
	3/8	.....	.....	1.828	32.90	1.782	32.08	1.454	26.17				
	7/16	.....	.....	2.102	37.84	2.047	36.85	1.664	29.95				
	1/2	.....	.....	2.375	42.75	2.312	41.62	1.875	33.75				
3½ × 2½	1/4	.....	.....	1.252	22.54	1.221	21.98	1.002	18.04				
	5/16	.....	.....	1.546	27.83	1.507	27.13	1.234	22.21				
	3/8	.....	.....	1.828	32.90	1.782	32.08	1.454	26.17				
	7/16	.....	.....	2.102	37.84	2.047	36.85	1.664	29.95				
	1/2	.....	.....	2.375	42.75	2.312	41.62	1.875	33.75				
3½ × 3½	5/16	.....	.....	.....	.....	1.817	32.71	1.544	27.79	1.777	31.99	1.466	26.39
	3/8	.....	.....	.....	.....	2.152	38.74	1.824	32.83	2.105	37.89	1.730	31.14
	7/16	.....	.....	.....	.....	2.487	44.77	2.104	37.87	2.432	43.78	1.994	35.89
	1/2	.....	.....	.....	.....	2.812	50.62	2.375	42.75	2.750	49.50	2.250	40.50
	9/16	.....	.....	.....	.....	3.128	56.30	2.636	47.45	3.057	55.03	2.494	44.89
	5/8	.....	.....	.....	.....	3.433	61.79	2.886	51.95	3.355	60.39	2.730	49.14
4 × 3	5/16	.....	.....	.....	.....	1.817	32.71	1.544	27.79	1.777	31.99	1.466	26.39
	3/8	.....	.....	.....	.....	2.152	38.74	1.824	32.83	2.105	37.89	1.730	31.14
	7/16	.....	.....	.....	.....	2.487	44.77	2.104	37.87	2.432	43.78	1.994	35.89
	1/2	.....	.....	.....	.....	2.812	50.62	2.375	42.75	2.750	49.50	2.250	40.50
	9/16	.....	.....	.....	.....	3.128	56.30	2.636	47.45	3.057	55.03	2.494	44.89
	5/8	.....	.....	.....	.....	3.433	61.79	2.886	51.95	3.355	60.39	2.730	49.14
4 × 3½	5/16	.....	.....	.....	.....	1.977	35.59	1.704	30.67	1.938	34.88	1.626	29.27
	3/8	.....	.....	.....	.....	2.342	42.16	2.014	36.25	2.295	41.31	1.920	34.56
	7/16	.....	.....	.....	.....	2.707	48.73	2.324	41.83	2.652	47.74	2.214	39.85
	1/2	.....	.....	.....	.....	3.062	55.12	2.624	47.23	3.000	54.00	2.500	45.00
	9/16	.....	.....	.....	.....	3.408	61.34	2.916	52.49	3.337	60.07	2.774	49.93
	5/8	.....	.....	.....	.....	3.753	67.55	3.206	57.71	3.675	66.15	3.050	54.90
	11/16	.....	.....	.....	.....	4.078	73.40	3.476	62.57	3.992	71.86	3.304	59.47
	3/4	.....	.....	.....	.....	4.404	79.27	3.748	67.46	4.310	77.58	3.560	64.08
4 × 4	5/16	.....	.....	.....	.....	2.127	38.29	1.854	33.37	2.087	37.57	1.774	31.93
	3/8	.....	.....	.....	.....	2.532	45.58	2.204	39.67	2.485	44.73	2.110	37.98
	7/16	.....	.....	.....	.....	2.927	52.69	2.544	45.79	2.872	51.70	2.434	43.81
	1/2	.....	.....	.....	.....	3.312	59.62	2.874	51.73	3.250	58.50	2.750	49.50
	9/16	.....	.....	.....	.....	3.688	66.38	3.196	57.53	3.617	65.11	3.054	54.97
	5/8	.....	.....	.....	.....	4.063	73.13	3.516	63.29	3.985	71.73	3.360	60.48
	11/16	.....	.....	.....	.....	4.428	79.70	3.826	68.87	4.342	78.16	3.654	65.77
	3/4	.....	.....	.....	.....	4.784	86.11	4.128	74.30	4.690	84.42	3.940	70.92
5 × 3	5/16	.....	.....	.....	.....	2.127	38.29	1.854	33.37	2.087	37.57	1.775	31.95
	3/8	.....	.....	.....	.....	2.532	45.58	2.204	39.67	2.485	44.73	2.110	37.98
	7/16	.....	.....	.....	.....	2.927	52.69	2.544	45.79	2.872	51.70	2.435	43.83
	1/2	.....	.....	.....	.....	3.312	59.62	2.874	51.73	3.250	58.50	2.750	49.50
	9/16	.....	.....	.....	.....	3.688	66.38	3.196	57.53	3.617	65.11	3.055	54.99
	5/8	.....	.....	.....	.....	4.063	73.13	3.516	63.29	3.985	71.73	3.360	60.48
	11/16	.....	.....	.....	.....	4.428	79.70	3.826	68.87	4.342	78.16	3.655	65.79
	3/4	.....	.....	.....	.....	4.784	86.11	4.128	74.30	4.690	84.42	3.940	70.92

★Angles are classified as in Bar Size when their greatest dimension is less than 3 inches.

NET AREAS AND TENSILE VALUES OF ONE ANGLE IN KIPS
TENSION AT 18000 POUNDS PER SQUARE INCH
TO DEVELOP VALUES BELOW, ANGLES MUST BE ATTACHED BY BOTH LEGS

STANDARD ANGLES

Size in Inches	Thickness	¾" RIVET				⅞" RIVET				1" RIVET			
		1 HOLE OUT		2 HOLES OUT		1 HOLE OUT		2 HOLES OUT		1 HOLE OUT		2 HOLES OUT	
		Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value	Net Area	Tens. Value
5 × 3½	5/16	2.287	41.17	2.014	36.25	2.248	40.46	1.936	34.85				
	3/8	2.722	49.00	2.394	43.09	2.675	48.15	2.300	41.40				
	7/16	3.147	56.65	2.764	49.75	3.092	55.66	2.654	47.77				
	1/2	3.562	64.12	3.124	56.23	3.500	63.00	3.000	54.00				
	9/16	3.978	71.60	3.486	62.75	3.907	70.33	3.344	60.19				
	5/8	4.373	78.71	3.826	68.87	4.295	77.31	3.670	66.06				
	11/16	4.768	85.82	4.166	74.99	4.682	84.28	3.994	71.89				
	3/4	5.154	92.77	4.498	80.96	5.060	91.08	4.310	77.58				
6 × 3½	3/8	3.092	55.66	2.764	49.75	3.045	54.81	2.670	48.06				
	7/16	3.587	64.57	3.204	57.67	3.532	63.58	3.095	55.71				
	1/2	4.062	73.12	3.624	65.23	4.000	72.00	3.500	63.00				
	9/16	4.538	81.68	4.046	72.83	4.467	80.41	3.905	70.29				
	5/8	5.003	90.05	4.456	80.21	4.925	88.65	4.300	77.40				
	11/16	5.458	98.24	4.856	87.41	5.372	96.70	4.685	84.33				
	3/4	5.904	106.27	5.248	94.46	5.810	104.58	5.060	91.08				
	13/16	6.349	114.28	5.638	101.48	6.247	112.45	5.435	97.83				
	7/8	6.784	122.11	6.018	108.32	6.675	120.15	5.800	104.40				
6 × 4	3/8	3.282	59.08	2.954	53.17	3.235	58.23	2.860	51.48	3.188	57.38	2.766	49.79
	7/16	3.797	68.35	3.414	61.45	3.742	67.36	3.304	59.47	3.688	66.38	3.196	57.53
	1/2	4.312	77.62	3.874	69.73	4.250	76.50	3.750	67.50	4.187	75.37	3.624	65.23
	9/16	4.818	86.72	4.326	77.87	4.747	85.45	4.184	75.31	4.677	84.19	4.044	72.79
	5/8	5.313	95.63	4.766	85.79	5.235	94.23	4.610	82.98	5.157	92.84	4.454	80.17
	11/16	5.798	104.36	5.196	93.53	5.712	102.82	5.024	90.43	5.627	101.29	4.854	87.37
	3/4	6.284	113.11	5.628	101.30	6.190	111.42	5.440	97.92	6.096	109.73	5.252	94.54
	13/16	6.759	121.66	6.048	108.86	6.657	119.83	5.844	105.19	6.556	118.01	5.642	101.56
	7/8	7.214	129.85	6.448	116.06	7.105	127.89	6.230	112.14	6.996	125.93	6.012	108.22
6 × 6	3/8	4.032	72.58	3.704	66.67	3.985	71.73	3.610	64.98	3.938	70.88	3.516	63.29
	7/16	4.677	84.19	4.294	77.29	4.622	83.20	4.184	75.31	4.568	82.22	4.076	73.37
	1/2	5.312	95.62	4.874	87.73	5.250	94.50	4.750	85.50	5.187	93.37	4.624	83.23
	9/16	5.938	106.88	5.446	98.03	5.867	105.61	5.304	95.47	5.797	104.35	5.164	92.95
	5/8	6.563	118.13	6.016	108.29	6.485	116.73	5.860	105.48	6.407	115.33	5.704	102.67
	11/16	7.178	129.20	6.576	118.37	7.092	127.66	6.404	115.27	7.007	126.13	6.234	112.21
	3/4	7.784	140.11	7.128	128.30	7.690	138.42	6.940	124.92	7.596	136.73	6.752	121.54
	13/16	8.379	150.82	7.668	138.02	8.277	148.99	7.464	134.35	8.176	147.17	7.262	130.72
	7/8	8.964	161.35	8.198	147.56	8.855	159.39	7.980	143.64	8.746	157.43	7.762	139.72
	15/16	.....	.....	.....	.....	9.432	169.78	8.494	152.89	9.315	167.67	8.260	148.68
	1	.....	.....	.....	.....	10.000	180.00	9.000	162.00	9.875	177.75	8.750	157.50
7 × 3½	3/8	3.472	62.50	3.144	56.59	3.425	61.65	3.050	54.90	3.378	60.80	2.956	53.21
	7/16	4.017	72.31	3.634	65.41	3.962	71.32	3.524	63.43	3.908	70.34	3.416	61.49
	1/2	4.562	82.12	4.124	74.23	4.500	81.00	4.000	72.00	4.437	79.87	3.874	69.73
	9/16	5.098	91.76	4.606	82.91	5.027	90.49	4.464	80.35	4.957	89.23	4.324	77.83
	5/8	5.623	101.21	5.076	91.37	5.545	99.81	4.920	88.56	5.467	98.41	4.764	85.75
	11/16	6.148	110.66	5.546	99.83	6.062	109.12	5.374	96.73	5.977	107.59	5.204	93.67
	3/4	6.654	119.77	5.998	107.96	6.560	118.08	5.810	104.58	6.466	116.39	5.622	101.20
	13/16	7.159	128.86	6.448	116.06	7.057	127.03	6.244	112.39	6.956	125.21	6.042	108.76
	7/8	7.654	137.77	6.888	123.98	7.545	135.81	6.670	120.06	7.436	133.85	6.452	116.14
	15/16	.....	.....	.....	.....	8.032	144.58	7.094	127.69	7.915	142.47	6.861	123.49
	1	.....	.....	.....	.....	8.500	153.00	7.500	135.00	8.375	150.75	7.250	130.50
8 × 6	7/16	5.547	99.85	5.164	92.95	5.492	98.86	5.054	90.97	5.438	97.88	4.946	89.03
	1/2	6.312	113.62	5.874	105.73	6.250	112.50	5.750	103.50	6.187	111.37	5.624	101.23
	9/16	7.068	127.22	6.576	118.37	6.997	125.95	6.434	115.81	6.927	124.69	6.294	113.29
	5/8	7.813	140.63	7.266	130.79	7.735	139.23	7.110	127.98	7.657	137.83	6.954	125.17
	11/16	8.548	153.86	7.946	143.03	8.462	152.32	7.774	139.93	8.377	150.79	7.604	136.87
	3/4	9.284	167.11	8.628	155.30	9.190	165.42	8.440	151.92	9.096	163.73	8.252	148.54
	13/16	10.009	180.16	9.298	167.36	9.907	178.33	9.095	163.71	9.806	176.51	8.892	160.06
	7/8	10.714	192.85	9.948	179.06	10.605	190.89	9.730	175.14	10.496	188.93	9.512	171.22
	15/16	.....	.....	.....	.....	11.312	203.62	10.374	186.73	11.195	201.51	10.140	182.52
	1	.....	.....	.....	.....	12.000	216.00	11.000	198.00	11.875	213.75	10.750	193.50
8 × 8	1/2	7.312	131.62	6.874	123.73	7.250	130.50	6.750	121.50	7.187	129.37	6.624	119.23
	9/16	8.188	147.38	7.696	138.53	8.117	146.11	7.554	135.97	8.047	144.85	7.414	133.45
	5/8	9.063	163.13	8.516	153.29	8.985	161.73	8.360	150.48	8.907	160.33	8.204	147.67
	11/16	9.928	178.70	9.326	167.87	9.842	177.16	9.154	164.77	9.757	175.63	8.984	161.71
	3/4	10.784	194.11	10.128	182.30	10.690	192.42	9.940	178.92	10.596	190.73	9.752	175.54
	13/16	11.629	209.32	10.918	196.52	11.527	207.49	10.714	192.85	11.426	205.67	10.512	189.22
	7/8	12.464	224.35	11.698	210.56	12.355	222.39	11.480	206.64	12.246	220.43	11.262	202.72
	15/16	.....	.....	.....	.....	13.182	237.28	12.244	220.39	13.065	235.17	12.010	216.18
	1	.....	.....	.....	.....	14.000	252.00	13.000	234.00	13.875	249.75	12.750	229.50
	1 1/16	.....	.....	.....	.....	14.807	266.53	13.744	247.39	14.675	264.15	13.480	242.64
	1 1/8	.....	.....	.....	.....	15.605	280.89	14.480	260.64	15.464	278.35	14.198	255.56

STRUTS OF ONE ANGLE
ALLOWABLE CONCENTRIC LOADS IN KIPS

Values given are for Least Radius of Gyration which is about Axis Z – Z.
Loads to right of heavy vertical line are for Secondary Members ONLY.

Size in Inches	Thickness	Weight per foot	Area in Sq.In.	Least Radius Gyr.	UNSUPPORTED LENGTH IN FEET										
					2	3	4	5	6	7	8	9	10	11	12
1¾ × 1¾	1/8	1.44	0.42	0.35	6.0	4.8	3.7	2.9							
	3/16	2.12	0.62	0.34	8.7	6.9	5.3	4.1							
	1/4	2.77	0.81	0.34	11.4	9.0	6.9	5.3							
2 × 2	1/8	1.65	0.48	0.40	7.2	6.0	4.8	3.8	3.1						
	3/16	2.44	0.72	0.39	10.7	8.8	7.0	5.7	4.5						
	1/4	3.19	0.94	0.39	14.0	11.5	9.2	7.4	5.8						
	5/16	3.92	1.15	0.39	17.1	14.1	11.2	9.1	7.2						
2½ × 2	1/8	1.86	0.55	0.43	8.3	7.1	5.8	4.8	3.9	3.2					
	3/16	2.75	0.81	0.43	12.2	10.5	8.6	7.0	5.7	4.7					
	1/4	3.62	1.06	0.42	15.9	13.5	11.1	8.9	7.2	5.9					
	5/16	4.50	1.31	0.42	19.7	16.7	13.7	11.0	8.9	7.3					
2½ × 2½	1/8	2.08	0.61	0.50	9.2	8.5	7.3	6.1	5.1	4.3	3.6				
	3/16	3.07	0.90	0.49	13.5	12.5	10.6	8.8	7.4	6.1	5.2				
	1/4	4.1	1.19	0.49	17.9	16.5	14.0	11.7	9.7	8.1	6.8				
	5/16	5.0	1.47	0.49	22.1	20.4	17.3	14.4	12.0	10.0	8.5				
	3/8	5.9	1.73	0.48	26.0	23.7	20.0	16.7	13.8	11.5					
3 × 2½	1/4	4.5	1.31	0.53	19.7	18.8	16.2	13.8	11.6	9.8	8.4				
	5/16	5.6	1.62	0.53	24.3	23.2	20.0	17.0	14.4	12.2	10.3				
	3/8	6.6	1.92	0.52	28.8	27.3	23.4	19.9	16.7	14.1	11.9				
	7/16	7.6	2.22	0.52	33.3	31.6	27.1	23.0	19.4	16.3	13.8				
3 × 3	1/4	4.9	1.44	0.59	21.6	21.5	19.0	16.5	14.2	12.2	10.5	9.1			
	5/16	6.1	1.78	0.59	26.7	26.5	23.4	20.3	17.5	15.1	13.0	11.2			
	3/8	7.2	2.11	0.58	31.7	31.3	27.5	23.8	20.5	17.5	15.1	13.0			
	7/16	8.3	2.43	0.58	36.5	36.0	31.7	27.4	23.6	20.2	17.4	14.9			
	1/2	9.4	2.75	0.58	41.3	40.8	35.9	31.0	26.7	22.9	19.6	16.9			
3½ × 2½	1/4	4.9	1.44	0.54	21.6	20.8	18.0	15.4	13.0	11.1	9.4	8.0			
	5/16	6.1	1.78	0.54	26.7	26.7	22.3	19.0	16.1	13.7	11.6	9.9			
	3/8	7.2	2.11	0.54	31.7	30.4	26.4	22.5	19.1	16.2	13.8	11.8			
	7/16	8.3	2.43	0.54	36.5	35.1	30.4	26.0	22.0	18.7	15.9	13.6			
	1/2	9.4	2.75	0.53	41.3	39.4	34.0	28.9	24.4	20.7	17.5				
3½ × 3½	5/16	7.2	2.09	0.69	31.4	31.4	29.6	26.5	23.4	20.6	18.1	15.9	14.0	12.4	
	3/8	8.5	2.48	0.68	37.2	37.2	35.0	31.2	27.5	24.2	21.2	18.6	16.3	14.4	
	7/16	9.8	2.87	0.68	43.1	43.1	40.5	36.1	31.8	28.0	24.5	21.5	18.9	16.7	
	1/2	11.1	3.25	0.68	48.8	48.8	45.8	40.9	36.0	31.7	27.8	24.4	21.4	18.9	
	9/16	12.4	3.62	0.68	54.3	54.3	51.0	45.5	40.1	35.3	30.9	27.2	23.9	21.1	
	5/8	13.6	3.98	0.68	59.7	59.7	56.1	50.0	44.1	38.8	34.0	29.9	26.2	23.2	
4 × 3	5/16	7.2	2.09	0.65	31.4	31.4	28.9	25.5	22.4	19.5	17.0	14.8	13.0		
	3/8	8.5	2.48	0.64	37.2	37.2	34.0	30.0	26.2	22.8	19.8	17.3	15.1		
	7/16	9.8	2.87	0.64	43.1	43.1	39.4	34.7	30.3	26.4	23.0	20.0	17.5		
	1/2	11.1	3.25	0.64	48.8	48.8	44.6	39.3	34.4	29.9	26.0	22.7	19.8		
	9/16	12.4	3.62	0.64	54.3	54.3	49.6	43.8	38.3	33.3	29.0	25.2	22.1		
	5/8	13.6	3.98	0.64	59.7	59.7	54.6	48.1	42.1	36.6	31.8	27.7	24.3		
4 × 3½	5/16	7.7	2.25	0.73	33.8	33.8	32.6	29.5	26.3	23.3	20.7	18.3	16.2	14.4	12.8
	3/8	9.1	2.67	0.73	40.1	40.1	38.7	35.0	31.2	27.7	24.5	21.7	19.2	17.1	15.2
	7/16	10.6	3.09	0.72	46.4	46.4	44.6	40.1	35.8	31.7	28.0	24.7	21.9	19.4	17.2
	1/2	11.9	3.50	0.72	52.5	52.5	50.5	45.5	40.5	35.9	31.7	28.0	24.8	22.0	19.5
	9/16	13.3	3.90	0.72	58.5	58.5	56.3	50.7	45.1	40.0	35.3	31.2	27.6	24.5	21.8
	5/8	14.7	4.30	0.72	64.5	64.5	62.1	55.9	49.8	44.1	39.0	34.4	30.4	27.0	24.0
	11/16	16.0	4.68	0.72	70.2	70.2	67.6	60.8	54.1	48.0	42.4	37.4	33.1	29.4	26.1
	3/4	17.3	5.06	0.72	75.9	75.9	73.1	65.7	58.5	51.9	45.8	40.5	35.8	31.8	28.2
4 × 4	5/16	8.2	2.40	0.79	36.0	36.0	35.9	32.7	29.6	26.5	23.7	21.2	18.9	16.9	15.2
	3/8	9.8	2.86	0.79	42.9	42.9	42.7	39.0	35.2	31.6	28.3	25.3	22.6	20.2	18.1
	7/16	11.3	3.31	0.78	49.7	49.7	49.2	44.9	40.4	36.2	32.3	28.9	25.7	23.0	20.6
	1/2	12.8	3.75	0.78	56.3	56.3	55.8	50.8	45.8	41.1	36.6	32.7	29.1	26.1	23.3
	9/16	14.3	4.18	0.78	62.7	62.7	62.2	56.6	51.1	45.8	40.8	36.4	32.5	29.1	26.0
	5/8	15.7	4.61	0.77	69.2	69.2	68.2	62.1	55.9	50.0	44.5	39.6	35.3	31.5	28.2
	11/16	17.1	5.03	0.77	75.5	75.5	74.4	67.7	61.0	54.5	48.6	43.3	38.5	34.4	30.8
	3/4	18.5	5.44	0.77	81.6	81.6	80.5	73.2	65.9	59.0	52.6	46.8	41.7	37.2	33.3
5 × 3	5/16	8.2	2.40	0.66	36.0	36.0	33.4	29.6	26.0	22.8	19.8	17.4	15.2	13.4	
	3/8	9.8	2.86	0.65	42.9	42.9	39.5	34.9	30.6	26.7	23.3	20.3	17.8		
	7/16	11.3	3.31	0.65	49.7	49.7	45.7	40.4	35.4	30.9	26.9	23.5	20.6		
	1/2	12.8	3.75	0.65	56.3	56.3	51.8	45.8	40.1	35.0	30.5	26.6	23.3		
	9/16	14.3	4.18	0.65	62.7	62.7	57.8	51.1	44.7	39.0	34.0	29.7	26.0		
	5/8	15.7	4.61	0.64	69.2	69.2	63.2	55.7	48.7	42.4	36.9	32.1	28.1		
	11/16	17.1	5.03	0.64	75.5	75.5	69.0	60.8	53.2	46.3	40.2	35.1	30.7		
	3/4	18.5	5.44	0.64	81.6	81.6	74.6	65.8	57.5	50.0	43.5	37.9	33.2		

STRUTS OF ONE ANGLE
ALLOWABLE CONCENTRIC LOADS IN KIPS

Values given are for Least Radius of Gyration which is about Axis Z – Z.
Loads to right of heavy vertical line are for Secondary Members ONLY.

Size in Inches	Thickness	Weight per foot	Area Sq. Inches	Least Radius Gyr.	UNSUPPORTED LENGTH IN FEET												
					3	4	5	6	7	8	10	12	14	16	18	20	22
5 × 3½	5/16	8.7	2.56	0.77	38	38	34	31	28	25	20	16					
	3/8	10.4	3.05	0.76	46	45	41	37	33	29	23	18					
	7/16	12.0	3.53	0.76	53	52	47	42	38	34	27	21					
	1/2	13.6	4.00	0.75	60	59	53	48	42	38	30	24					
	9/16	15.2	4.47	0.75	67	66	59	53	47	42	33	26					
	5/8	16.8	4.92	0.75	74	72	65	59	52	46	37	29					
	11/16	18.3	5.37	0.75	81	79	71	64	57	51	40	32					
	3/4	19.8	5.81	0.75	87	85	77	69	62	55	43	34					
6 × 3½	3/8	11.7	3.42	0.77	51	51	46	41	37	33	26	21					
	7/16	13.5	3.97	0.76	60	58	53	48	43	38	30	24					
	1/2	15.3	4.50	0.76	68	66	60	54	48	43	34	27					
	9/16	17.1	5.03	0.75	75	74	67	60	53	47	37	30					
	5/8	18.9	5.55	0.75	83	81	74	66	59	52	41	33					
	11/16	20.6	6.06	0.75	91	89	80	72	64	57	45	36					
	3/4	22.4	6.56	0.75	98	96	87	78	70	62	49	39					
	13/16	24.0	7.06	0.75	106	103	94	84	75	67	52	42					
	7/8	25.7	7.55	0.75	113	111	100	90	80	71	56	45					
6 × 4	3/8	12.3	3.61	0.88	54	54	52	47	43	39	32	26					
	7/16	14.3	4.18	0.87	63	63	60	55	50	45	37	30	24				
	1/2	16.2	4.75	0.87	71	71	68	62	56	51	42	34	28				
	9/16	18.1	5.31	0.87	80	80	76	69	63	57	46	38	31				
	5/8	20.0	5.86	0.86	88	88	83	76	69	62	51	41	34				
	11/16	21.8	6.40	0.86	96	96	91	83	75	68	55	45	37				
	3/4	23.6	6.94	0.86	104	104	98	90	82	74	60	49	40				
	13/16	25.4	7.47	0.86	112	112	106	97	88	79	65	53	43				
	7/8	27.2	7.98	0.86	120	120	113	103	94	85	69	56	46				
6 × 6	3/8	14.9	4.36	1.19	65	65	65	65	61	58	50	43	37	32	28		
	7/16	17.2	5.06	1.19	76	76	76	76	71	67	58	51	43	37	32		
	1/2	19.6	5.75	1.18	86	86	86	86	81	76	66	57	49	42	36		
	9/16	21.9	6.43	1.18	96	96	96	96	90	85	73	63	54	47	40		
	5/8	24.2	7.11	1.17	107	107	107	106	99	93	81	69	60	51	44		
	11/16	26.5	7.78	1.17	117	117	117	116	109	102	88	76	65	56	48		
	3/4	28.7	8.44	1.17	127	127	127	126	118	111	96	82	71	61	52		
	13/16	31.0	9.09	1.17	136	136	136	135	127	119	103	89	76	66	57		
	7/8	33.1	9.73	1.16	146	146	146	144	136	127	110	94	81	69	60		
	15/16	35.3	10.37	1.16	156	156	156	154	144	135	117	100	86	74	64		
	1	37.4	11.00	1.16	165	165	165	163	153	143	124	107	91	78	68		
7 × 3½	3/8	13.0	3.80	0.76	57	56	51	46	41	36	29	23					
	7/16	15.0	4.40	0.76	66	65	59	53	47	42	33	26					
	1/2	17.0	5.00	0.75	75	73	66	60	53	47	37	30					
	9/16	19.1	5.59	0.75	84	82	74	67	59	53	42	33					
	5/8	21.0	6.17	0.75	93	90	82	73	65	58	46	36					
	11/16	23.0	6.75	0.74	101	98	89	80	71	63	49	39					
	3/4	24.9	7.31	0.74	110	107	96	86	77	68	54	42					
	13/16	26.8	7.87	0.74	118	115	104	93	83	73	58	46					
	7/8	28.7	8.42	0.74	126	123	111	99	88	78	62	49					
	15/16	30.5	8.97	0.74	135	131	118	106	94	84	66	52					
	1	32.3	9.50	0.74	143	139	125	112	100	88	70	55					
8 × 6	7/16	20.2	5.93	1.30	89	89	89	89	87	82	72	63	55	48	42	37	
	1/2	23.0	6.75	1.30	101	101	101	101	99	93	82	72	63	55	48	42	
	9/16	25.7	7.56	1.30	113	113	113	113	110	104	92	81	71	61	54	47	
	5/8	28.5	8.36	1.29	125	125	125	125	122	115	102	89	77	67	59	51	
	11/16	31.2	9.15	1.29	137	137	137	137	133	126	111	97	85	74	64	56	
	3/4	33.8	9.94	1.28	149	149	149	149	144	136	120	105	91	80	69	61	
	13/16	36.5	10.72	1.28	161	161	161	161	156	147	130	113	99	86	75	65	
	7/8	39.1	11.48	1.28	172	172	172	172	167	157	139	121	106	92	80	70	
	15/16	41.7	12.25	1.28	184	184	184	184	178	168	148	129	113	98	85	75	
	1	44.2	13.00	1.28	195	195	195	195	189	178	157	137	120	104	91	79	
8 × 8	1/2	26.4	7.75	1.59	116	116	116	116	116	116	106	96	86	77	69	62	55
	9/16	29.6	8.68	1.58	130	130	130	130	130	130	118	107	96	86	77	68	61
	5/8	32.7	9.61	1.58	144	144	144	144	144	144	131	118	106	95	85	76	68
	11/16	35.8	10.53	1.58	158	158	158	158	158	157	144	130	116	104	93	83	74
	3/4	38.9	11.44	1.57	172	172	172	172	172	170	155	140	126	112	100	90	80
	13/16	42.0	12.34	1.57	185	185	185	185	185	184	168	151	136	121	108	97	86
	7/8	45.0	13.23	1.56	198	198	198	198	198	197	179	162	145	129	115	103	92
	15/16	48.1	14.12	1.56	212	212	212	212	212	210	191	173	155	138	123	110	98
	1	51.0	15.00	1.56	225	225	225	225	225	223	203	183	164	147	131	117	104
	1 1/16	54.0	15.87	1.56	238	238	238	238	238	236	215	194	174	155	138	123	110
	1 1/8	56.9	16.73	1.55	251	251	251	251	251	248	226	203	182	162	145	129	115

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO EQUAL ANGLES

Loads to right of heavy vertical lines are for Secondary Members ONLY.

AXIS Y-Y — X — X

3/8" BACK TO BACK

Size	Thickness	Two Angles Area	Two Angles Weight	Radius of Gyration X-X	Radius of Gyration Y-Y	AXIS X-X Unsupported Length in Feet 3	4	5	6	7	8	9	10	12	14	16	18	20	AXIS Y-Y Unsupported Length in Feet 6	7	8	9	10	12	14	16	18	20	22	24	26
2½ × 2½	3/16	1.80	6.1	.78	1.18	27	27	24	22	20	18	16	14	11	...	...	...	...	27	25	24	22	21	18	15	13	11				
	1/4	2.38	8.2	.77	1.19	36	35	32	29	26	23	21	18	15	...	...	...	...	36	34	31	29	27	24	20	18	15				
	5/16	2.94	10.0	.76	1.20	44	43	39	35	32	28	25	22	18	...	...	...	...	44	42	39	36	34	29	25	22	19	16			
	3/8	3.46	11.8	.75	1.21	52	51	46	41	37	33	29	26	20	...	...	...	...	52	49	46	43	40	35	30	26	23				
3 × 3	1/4	2.88	9.8	.93	1.38	43	43	42	39	36	33	30	27	22	18	...	...	...	43	43	41	39	37	32	28	25	22	19	17		
	5/16	3.56	12.2	.92	1.40	53	53	52	48	44	40	36	33	27	23	...	...	...	53	53	51	48	46	40	36	31	28	24	22		
	3/8	4.22	14.4	.91	1.41	63	63	61	56	52	47	43	39	32	26	...	...	...	63	63	60	57	54	48	42	37	33	29	26		
	7/16	4.86	16.6	.91	1.42	73	73	71	65	59	54	49	45	37	30	...	...	...	73	73	70	66	63	56	49	43	38	34	30		
3½ × 3½	5/16	4.18	14.4	1.08	1.60	63	63	63	60	56	52	48	45	38	32	27	...	...	63	63	63	60	57	52	47	42	37	33	30	27	24
	3/8	4.96	17.0	1.07	1.61	74	74	74	71	67	62	57	53	45	38	32	...	...	74	74	74	71	68	62	56	50	45	40	36	32	29
	7/16	5.74	19.6	1.07	1.62	86	86	86	83	77	71	66	61	52	44	37	...	...	86	86	86	83	79	72	65	58	52	47	42	37	34
	1/2	6.50	22.2	1.06	1.63	98	98	98	93	87	80	74	68	58	49	41	...	...	98	98	98	94	90	82	74	66	59	53	48	43	39
	9/16	7.24	24.8	1.05	1.64	109	109	109	103	96	89	82	76	64	54	46	...	...	109	109	109	105	100	91	82	74	66	59	53	48	43
	5/8	7.96	27.2	1.04	1.66	119	119	119	113	105	97	90	82	69	59	50	...	...	119	119	119	116	111	101	91	82	74	66	60	54	48
4 × 4	5/16	4.80	16.4	1.24	1.80	72	72	72	72	69	65	61	57	49	43	37	32	...	72	72	72	72	69	64	58	53	48	44	39	36	32
	3/8	5.72	19.6	1.23	1.81	86	86	86	86	82	77	72	67	59	51	44	38	...	86	86	86	86	83	76	70	63	57	52	47	43	39
	7/16	6.62	22.6	1.23	1.82	99	99	99	99	95	89	83	78	68	59	51	44	...	99	99	99	99	96	88	81	74	67	61	55	50	45
	1/2	7.50	25.6	1.22	1.83	113	113	113	113	107	100	94	88	76	66	57	49	...	113	113	113	113	109	100	92	84	76	69	63	57	52
	9/16	8.36	28.6	1.21	1.85	125	125	125	125	119	111	104	97	84	73	63	54	...	125	125	125	125	122	113	103	94	86	78	71	64	58
	5/8	9.22	31.4	1.20	1.86	138	138	138	138	131	122	114	107	92	79	69	59	...	138	138	138	138	135	124	114	104	95	86	78	71	65
6 × 6	3/8	8.72	29.8	1.88	2.62	131	131	131	131	131	131	131	128	118	109	99	91	82	131	131	131	131	131	131	128	121	114	107	100	94	88
	7/16	10.12	34.4	1.87	2.63	152	152	152	152	152	152	152	148	137	126	115	105	95	152	152	152	152	152	152	148	140	132	125	117	109	102
	1/2	11.50	39.2	1.86	2.64	173	173	173	173	173	173	173	168	155	143	130	118	108	173	173	173	173	173	173	169	160	151	142	133	125	117
	9/16	12.86	43.8	1.85	2.65	193	193	193	193	193	193	193	188	173	159	145	132	120	193	193	193	193	193	193	189	179	169	159	149	140	131
	5/8	14.22	48.4	1.84	2.66	213	213	213	213	213	213	213	207	191	175	160	145	132	213	213	213	213	213	213	210	198	187	176	165	155	145
	11/16	15.56	53.0	1.83	2.67	233	233	233	233	233	233	233	226	208	191	174	158	143	233	233	233	233	233	233	230	218	205	193	182	170	159
	3/4	16.88	57.4	1.83	2.68	253	253	253	253	253	253	253	245	226	207	189	171	156	253	253	253	253	253	253	249	236	223	210	197	185	173
	13/16	18.18	62.0	1.82	2.69	273	273	273	273	273	273	273	264	243	222	202	184	167	273	273	273	273	273	273	269	255	241	227	213	200	187
	7/8	19.46	66.2	1.81	2.70	292	292	292	292	292	292	292	282	259	237	216	196	177	292	292	292	292	292	292	288	273	258	243	229	215	201
	15/16	20.74	70.6	1.80	2.71	311	311	311	311	311	311	311	300	275	252	229	207	188	311	311	311	311	311	311	308	292	276	260	245	229	215
	1"	22.00	74.8	1.80	2.72	330	330	330	330	330	330	330	318	292	267	243	220	199	330	330	330	330	330	330	327	310	293	277	260	244	229
8 × 8	1/2	15.50	52.8	2.51	3.44	233	233	233	233	233	233	233	233	233	223	211	198	185	233	233	233	233	233	233	233	233	229	219	210	201	191
	9/16	17.36	59.2	2.50	3.46	260	260	260	260	260	260	260	260	260	250	235	221	207	260	260	260	260	260	260	260	260	257	247	236	226	215
	5/8	19.22	65.4	2.49	3.47	288	288	288	288	288	288	288	288	288	276	260	244	228	288	288	288	288	288	288	288	288	285	273	262	250	239
	11/16	21.06	71.6	2.48	3.48	316	316	316	316	316	316	316	316	316	302	284	267	249	316	316	316	316	316	316	316	316	312	300	287	275	262
	3/4	22.88	77.8	2.47	3.49	343	343	343	343	343	343	343	343	343	328	308	289	270	343	343	343	343	343	343	343	343	340	326	313	299	285
	13/16	24.68	84.0	2.46	3.50	370	370	370	370	370	370	370	370	370	353	332	311	291	370	370	370	370	370	370	370	370	367	352	338	323	308
	7/8	26.46	90.0	2.45	3.51	397	397	397	397	397	397	397	397	397	378	355	333	311	397	397	397	397	397	397	397	397	393	378	362	347	331
	15/16	28.24	96.2	2.44	3.52	424	424	424	424	424	424	424	424	424	402	378	354	331	424	424	424	424	424	424	424	424	420	404	387	371	354
	1"	30.00	102.0	2.44	3.53	450	450	450	450	450	450	450	450	450	428	402	376	351	450	450	450	450	450	450	450	450	447	430	412	394	377
	1 1/16	31.74	108.0	2.43	3.54	476	476	476	476	476	476	476	476	476	451	424	397	370	476	476	476	476	476	476	476	476	473	455	436	418	399
	1 1/8	33.46	113.8	2.42	3.55	502	502	502	502	502	502	502	502	502	475	446	417	389	502	502	502	502	502	502	502	502	499	480	461	441	421

LOADS BY A. I. S. C. SPECIFICATION

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO EQUAL ANGLES

$1/2''$ BACK TO BACK

Loads to right of heavy vertical lines are for Secondary Members ONLY.

Size	Thickness	Two Angles Area	Two Angles Weight	Radius of Gyration X-X	Radius of Gyration Y-Y	Axis X-X, Unsupported Length in Feet: 3	4	5	6	7	8	9	10	12	14	16	18	20
2½ × 2½	3/16	1.80	6.1	.78	1.22	27	27	24	22	20	18	16	14	11	...	...	...	...
	1/4	2.38	8.2	.77	1.24	36	35	32	29	26	23	21	18	15	...	...	...	...
	5/16	2.94	10.0	.76	1.25	44	43	39	35	32	28	25	22	18	...	...	...	...
	3/8	3.46	11.8	.75	1.26	52	51	46	41	37	33	29	26	20	...	...	...	...
3 × 3	1/4	2.88	9.8	.93	1.43	43	43	42	39	36	33	30	27	22	18	...	...	...
	5/16	3.56	12.2	.92	1.45	53	53	52	48	44	40	36	33	27	23	...	...	...
	3/8	4.22	14.4	.91	1.46	63	63	61	56	52	47	43	39	32	26	...	...	...
	7/16	4.86	16.6	.91	1.47	73	73	71	65	59	54	49	45	37	30	...	...	...
3½ × 3½	5/16	4.18	14.4	1.08	1.65	63	63	63	60	56	52	48	45	38	32	27	...	...
	3/8	4.96	17.0	1.07	1.66	74	74	74	71	67	62	57	53	45	38	32	...	...
	7/16	5.74	19.6	1.07	1.67	86	86	86	83	77	71	66	61	52	44	37	...	...
	1/2	6.50	22.2	1.06	1.68	98	98	98	93	87	80	74	68	58	49	41	...	...
	9/16	7.24	24.8	1.05	1.69	109	109	109	103	96	89	82	76	64	54	46	...	...
	5/8	7 96	27.2	1.04	1.70	119	119	119	113	105	97	90	82	69	59	50	...	...
4 × 4	5/16	4.80	16.4	1.24	1.85	72	72	72	72	69	65	61	57	49	43	37	32	..
	3/8	5.72	19.6	1.23	1.86	86	86	86	86	82	77	72	67	59	51	44	38	...
	7/16	6.62	22.6	1.23	1.87	99	99	99	99	95	89	83	78	68	59	51	44	...
	1/2	7.50	25.6	1.22	1.88	113	113	113	113	107	100	94	88	76	66	57	49	...
	9/16	8.36	28.6	1.21	1.90	125	125	125	125	119	111	104	97	84	73	63	54	...
	5/8	9 22	31.4	1.20	1.91	138	138	138	138	131	122	114	107	92	79	69	59	...
6 × 6	3/8	8.72	29.8	1.88	2.66	131	131	131	131	131	131	131	128	118	109	99	91	82
	7/16	10.12	34.4	1.87	2.67	152	152	152	152	152	152	152	148	137	126	115	105	95
	1/2	11.50	39.2	1.86	2.68	173	173	173	173	173	173	173	168	155	143	130	118	108
	9/16	12.86	43.8	1.85	2.70	193	193	193	193	193	193	193	188	173	159	145	132	120
	5/8	14.22	48.4	1.84	2.71	213	213	213	213	213	213	213	207	191	175	160	145	132
	11/16	15.56	53.0	1.83	2.71	233	233	233	233	233	233	233	226	208	191	174	158	143
	3/4	16.88	57.4	1.83	2.73	253	253	253	253	253	253	253	245	226	207	189	171	156
	13/16	18.18	62.0	1.82	2.74	273	273	273	273	273	273	273	264	243	222	202	184	167
	7/8	19.46	66.2	1.81	2.75	292	292	292	292	292	292	292	282	259	237	216	196	177
	15/16	20.74	70.6	1.80	2.76	311	311	311	311	311	311	311	300	275	252	229	207	188
	1″	22 00	74.8	1.80	2.77	330	330	330	330	330	330	330	318	292	267	243	220	199
8 × 8	1/2	15.50	52.8	2.51	3.50	233	233	233	233	233	233	233	233	233	223	211	198	185
	9/16	17.36	59.2	2.50	3.50	260	260	260	260	260	260	260	260	260	250	235	221	207
	5/8	19.22	65.4	2.49	3.51	288	288	288	288	288	288	288	288	288	276	260	244	228
	11/16	21.06	71.6	2.48	3.52	316	316	316	316	316	316	316	316	316	302	284	267	249
	3/4	22 88	77.8	2.47	3.54	343	343	343	343	343	343	343	343	343	328	308	289	270
	13/16	24.68	84.0	2.46	3.54	370	370	370	370	370	370	370	370	370	353	332	311	291
	7/8	26.46	90.0	2.45	3.55	397	397	397	397	397	397	397	397	397	378	355	333	311
	15/16	28.24	96.2	2.44	3.56	424	424	424	424	424	424	424	424	424	402	378	354	331
	1″	30.00	102.0	2.44	3.58	450	450	450	450	450	450	450	450	450	428	402	376	351
	1 1/16	31.74	108.0	2.43	3.59	476	476	476	476	476	476	476	476	476	451	424	397	370
	1 1/8	33.46	113.8	2.42	3.60	502	502	502	502	502	502	502	502	502	475	446	417	389

Size	Thickness	Axis Y-Y, Unsupported Length in Feet: 6	7	8	9	10	12	14	16	18	20	22	24	26
2½ × 2½	3/16	27	26	24	23	21	18	16	14	12				
	1/4	36	34	32	30	28	24	21	18	16	14			
	5/16	44	42	40	37	35	30	26	23	20	17			
	3/8	52	50	47	44	42	36	31	27	24	21			
3 × 3	1/4	43	43	41	39	37	33	29	26	23	20	18		
	5/16	53	53	52	49	46	41	37	32	29	25	23	20	
	3/8	63	63	61	58	55	50	44	39	34	31	27	24	
	7/16	73	73	71	67	64	57	51	45	40	35	31	28	
3½ × 3½	5/16	63	63	63	61	58	53	48	43	39	35	31	28	25
	3/8	74	74	74	72	69	63	57	51	46	41	37	34	30
	7/16	86	86	86	84	80	73	66	60	54	48	43	39	35
	1/2	98	98	98	95	91	83	75	68	61	55	49	44	40
	9/16	109	109	109	106	102	93	84	76	68	61	55	50	45
	5/8	119	119	119	117	112	102	93	84	76	68	61	55	50
4 × 4	5/16	72	72	72	72	70	65	59	54	49	45	41	37	34
	3/8	86	86	86	86	83	77	71	65	59	53	49	44	40
	7/16	99	99	99	99	97	90	82	75	69	62	57	51	47
	1/2	113	113	113	113	110	102	94	86	78	71	65	59	53
	9/16	125	125	125	125	123	114	105	96	88	80	73	66	60
	5/8	138	138	138	138	136	126	116	106	97	88	81	73	67
6 × 6	3/8	131	131	131	131	131	131	129	122	115	108	102	95	89
	7/16	152	152	152	152	152	152	149	141	133	126	118	111	103
	1/2	172	172	172	172	172	172	170	161	152	143	134	126	118
	9/16	193	193	193	193	193	193	190	181	171	161	151	142	133
	5/8	213	213	213	213	213	213	211	200	189	178	168	158	148
	11/16	233	233	233	233	233	233	231	219	207	195	183	172	161
	3/4	253	253	253	253	253	253	250	239	226	212	200	188	176
	13/16	273	273	273	273	273	273	271	257	243	229	216	203	190
	7/8	292	292	292	292	292	292	290	276	261	246	232	218	204
	15/16	311	311	311	311	311	311	310	294	279	263	247	232	218
	1″	330	330	330	330	330	330	329	313	296	279	263	247	232
8 × 8	1/2	232	232	232	232	232	232	232	232	230	221	212	203	194
	9/16	260	260	260	260	260	260	260	260	257	247	238	227	217
	5/8	288	288	288	288	288	288	288	288	285	275	264	252	240
	11/16	316	316	316	316	316	316	316	316	313	301	289	276	264
	3/4	343	343	343	343	343	343	343	343	341	328	315	301	288
	13/16	370	370	370	370	370	370	370	370	368	354	339	325	310
	7/8	397	397	397	397	397	397	397	397	395	380	364	349	333
	15/16	424	424	424	424	424	424	424	424	422	406	389	373	356
	1″	450	450	450	450	450	450	450	450	449	432	415	397	380
	1 1/16	476	476	476	476	476	476	476	476	476	458	439	421	402
	1 1/8	502	502	502	502	502	502	502	502	502	483	464	444	425

LOADS BY A. I. S. C. SPECIFICATION

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO UNEQUAL ANGLES

3/8″ BACK TO BACK

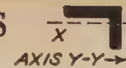
SHORT LEGS BACK TO BACK

AXIS Y-Y

Loads to right of heavy vertical lines are for Secondary Members ONLY.

Size	Thickness	Two Angles		Radius of Gyration		AXIS X - X, Unsupported Length in Feet											AXIS Y - Y, Unsupported Length in Feet														
		Area	Weight	X-X	Y-Y	3	4	5	6	7	8	9	10	12	14	16	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30
2½ × 2	3/16	1.62	5.5	.60	1.24	24	22	19	16	14	12	10	9	...	...	...	24	23	22	21	19	17	14	13	11	9					
	1/4	2.12	7.2	.59	1.25	32	28	24	21	18	15	13	...	...	...	...	32	30	29	27	25	22	19	17	14	13					
	5/16	2.62	9.0	.58	1.26	39	34	30	25	22	19	16	...	...	...	...	39	38	36	33	31	27	24	21	18	16					
3 × 2½	1/4	2.62	9.0	.75	1.45	39	38	35	31	28	25	22	20	16	...	...	39	39	38	36	34	31	27	24	21	19	17	15			
	5/16	3.24	11.2	.74	1.46	49	47	43	38	34	30	27	24	19	...	...	49	49	47	45	42	38	34	30	26	23	21	19			
	3/8	3.84	13.2	.74	1.48	58	56	51	45	40	36	32	28	22	...	...	58	58	56	53	51	45	40	36	32	28	25	22			
	7/16	4.42	15.2	.73	1.49	66	64	58	52	46	41	36	32	25	...	...	66	66	65	62	58	52	47	41	37	33	29	26			
3½ × 2½	1/4	2.88	9.8	.74	1.71	43	42	38	34	30	27	24	21	17	...	...	43	43	43	43	41	37	34	31	27	25	22	20	18	17	
	5/16	3.56	12.2	.73	1.73	53	52	46	42	37	33	29	26	20	...	...	53	53	53	53	51	46	42	38	34	31	28	25	23	21	
	3/8	4.22	14.4	.72	1.74	63	61	55	49	43	38	34	30	24	...	...	63	63	63	63	60	55	50	45	41	37	33	30	27	25	
	7/16	4.86	16.6	.71	1.75	73	70	63	56	49	43	38	34	...	...	...	73	73	73	72	69	64	58	52	47	43	39	35	32	29	
	1/2	5.50	18.8	.70	1.76	83	78	70	62	55	48	43	38	...	...	...	83	83	83	82	79	72	66	60	54	49	44	40	36	33	
4 × 3	5/16	4.18	14.4	.89	1.93	63	63	60	55	51	46	42	37	31	25	...	63	63	63	63	62	57	53	49	44	41	37	34	31	28	
	3/8	4.96	17.0	.88	1.94	74	74	71	65	60	54	49	44	36	30	...	74	74	74	74	73	68	63	58	53	48	44	40	37	33	
	7/16	5.74	19.6	.87	1.95	86	86	82	75	68	62	56	50	41	34	...	86	86	86	86	85	79	73	67	61	56	51	47	43	39	36
	1/2	6.50	22.2	.86	1.96	98	98	92	84	76	69	62	56	46	38	...	98	98	98	98	97	90	83	76	70	64	58	53	49	44	41
	9/16	7.24	24.8	.86	1.97	109	109	103	94	85	77	69	63	51	42	...	109	109	109	109	108	100	93	85	78	71	65	60	54	50	46
	5/8	7.96	27.2	.85	1.98	119	119	112	102	93	84	75	68	55	45	...	119	119	119	119	119	111	102	94	86	79	72	66	60	55	51
4 × 3½	5/16	4.50	15.4	1.07	1.86	68	68	68	65	60	56	52	48	40	34	29	68	68	68	68	66	61	56	51	46	42	38	35	32	29	
	3/8	5.34	18.2	1.06	1.88	80	80	80	76	71	66	61	56	47	40	34	80	80	80	80	78	73	67	61	55	50	46	42	38	35	
	7/16	6.18	21.2	1.05	1.88	93	93	93	88	82	76	70	64	54	46	39	93	93	93	93	91	84	77	70	64	58	53	48	44	40	
	1/2	7.00	23.8	1.04	1.89	105	105	105	100	92	86	79	72	61	51	44	105	105	105	105	103	95	88	80	73	66	60	55	50	46	
	9/16	7.80	26.6	1.03	1.90	117	117	117	110	102	95	87	80	67	57	48	117	117	117	117	115	106	98	90	82	74	68	62	56	51	
	5/8	8.60	29.4	1.02	1.91	129	129	129	121	112	104	95	88	73	62	52	129	129	129	129	127	118	108	99	91	82	75	68	62	57	
	11/16	9.36	32.0	1.02	1.93	140	140	140	132	122	113	104	95	80	67	57	140	140	140	140	139	129	119	109	99	91	83	75	69	63	
	3/4	10.12	34.6	1.01	1.94	152	152	152	142	132	121	111	102	86	72	61	152	152	152	152	150	139	129	118	108	98	90	82	75	68	
5 × 3	5/16	4.80	16.4	.85	2.47	72	72	67	62	56	51	46	41	33	27	...	72	72	72	72	72	72	69	65	61	57	53	49	46	43	40
	3/8	5.72	19.6	.84	2.48	86	86	80	73	66	60	53	48	39	32	...	86	86	86	86	86	86	82	77	72	68	63	59	55	51	47
	7/16	6.62	22.6	.84	2.49	99	99	93	85	77	69	62	56	45	37	...	99	99	99	99	99	99	95	90	84	79	73	68	64	59	55
	1/2	7.50	25.6	.83	2.50	113	113	105	95	86	77	70	62	50	...	...	113	113	113	113	113	113	108	102	95	89	83	78	72	67	63
	9/16	8.36	28.6	.82	2.52	125	125	116	105	95	85	77	69	55	...	...	125	125	125	125	125	125	121	114	107	100	93	87	81	76	70
	5/8	9.22	31.4	.82	2.53	138	138	128	116	105	94	85	76	61	...	...	138	138	138	138	138	138	133	126	118	111	103	97	90	84	78
	11/16	10.06	34.2	.81	2.54	151	151	139	126	113	102	91	82	66	...	...	151	151	151	151	151	151	146	137	129	121	113	106	98	92	86
	3/4	10.88	37.0	.80	2.55	163	163	149	135	121	109	97	87	70	...	...	163	163	163	163	163	163	158	150	140	131	123	115	107	100	93
5 × 3½	5/16	5.12	17.4	1.03	2.39	77	77	77	72	67	62	57	52	44	37	31	77	77	77	77	77	77	72	68	63	59	55	51	47	44	41
	3/8	6.10	20.8	1.02	2.40	91	91	91	86	80	74	68	62	52	44	37	92	92	92	92	92	92	86	81	76	71	66	61	57	53	49
	7/16	7.06	24.0	1.01	2.41	106	106	106	99	92	85	78	71	60	50	42	106	106	106	106	106	106	100	94	88	82	76	71	66	61	57
	1/2	8.00	27.2	1.01	2.43	120	120	120	112	104	96	88	81	67	56	48	120	120	120	120	120	120	114	107	100	93	87	81	75	70	65
	9/16	8.94	30.4	1.00	2.44	134	134	134	125	116	106	98	89	75	63	53	134	134	134	134	134	134	127	120	112	105	98	91	84	78	73
	5/8	9.84	33.6	.99	2.45	148	148	147	137	127	116	107	98	81	68	57	148	148	148	148	148	148	140	132	124	116	108	100	93	87	80
	11/16	10.74	36.6	.98	2.46	161	161	160	149	137	126	115	105	88	73	62	161	161	161	161	161	161	154	144	135	126	118	110	102	95	88
	3/4	11.62	39.6	.98	2.48	174	174	173	161	149	136	125	114	95	79	67	174	174	174	174	174	174	167	157	147	138	128	120	111	104	96

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO UNEQUAL ANGLES



3/8" BACK TO BACK

SHORT LEGS BACK TO BACK

Loads to right of heavy vertical lines are for Secondary Members ONLY.

Size	Thickness	Two Angles Area	Two Angles Weight	Radius of Gyration X-X	Radius of Gyration Y-Y	Axis X-X 4	5	6	7	8	9	10	12	14	16	18	20	Axis Y-Y 14	16	18	20	22	24	26	28	30	32	34	36	38	40
6 × 3½	3/8	6.84	23.4	.99	2.95	103	102	95	88	81	74	68	57	47	40	...	...	103	100	95	90	85	81	76	72	67	63	60	56	53	50
	7/16	7.94	27.0	.98	2.96	119	118	110	102	93	85	78	65	54	46	...	...	119	116	110	105	99	94	88	83	78	74	70	65	62	58
	1/2	9.00	30.6	.97	2.97	135	133	124	114	105	98	87	73	61	51	...	...	135	131	125	119	113	106	100	95	89	84	79	74	70	66
	9/16	10.06	34.2	.96	2.99	151	149	138	127	116	106	97	80	67	56	...	...	151	147	140	133	126	119	113	106	100	94	89	84	79	74
	5/8	11.10	37.8	.96	3.00	167	164	152	140	128	117	107	89	74	62	...	...	167	163	155	147	140	132	125	118	111	105	99	93	87	82
	11/16	12.12	41.2	.95	3.01	182	179	165	152	139	127	116	96	80	...	...	...	182	178	170	161	153	145	137	129	122	115	108	102	96	90
	3/4	13.12	44.8	.94	3.03	197	193	178	164	149	136	124	102	85	...	...	...	197	193	184	175	166	157	149	140	132	125	118	111	105	99
	13/16	14.12	48.0	.94	3.04	212	207	192	176	161	147	133	110	92	...	...	...	212	208	199	189	179	169	160	152	143	135	127	120	113	107
	7/8	15.10	51.4	.93	3.05	227	221	204	187	171	155	141	117	97	...	...	...	227	223	213	202	192	182	172	162	153	145	136	129	121	114
6 × 4	3/8	7.22	24.6	1.17	2.87	108	108	107	101	95	88	82	71	60	52	45	...	108	104	99	94	88	83	78	74	69	65	61	58	54	51
	7/16	8.36	28.6	1.16	2.88	125	125	124	117	109	102	95	81	69	59	50	...	125	121	115	109	103	97	91	86	81	76	71	67	63	59
	1/2	9.50	32.4	1.15	2.90	142	142	140	132	124	115	107	92	78	67	58	...	143	138	131	124	117	110	104	98	92	87	81	77	72	68
	9/16	10.62	36.2	1.14	2.91	159	159	157	147	137	127	119	102	87	74	64	...	159	154	146	139	131	124	117	110	103	97	91	86	81	76
	5/8	11.72	40.0	1.13	2.92	176	176	172	162	150	139	130	111	94	81	70	...	176	170	162	153	145	137	129	122	114	108	101	95	90	84
	11/16	12.80	43.6	1.13	2.94	192	192	188	176	164	153	142	121	103	88	76	...	192	186	177	168	159	150	142	134	126	118	111	105	99	93
	3/4	13.88	47.2	1.12	2.95	208	208	203	190	177	165	153	130	111	95	81	...	208	202	193	183	173	163	154	145	137	129	121	114	107	101
	13/16	14.94	50.8	1.11	2.96	224	224	218	204	190	176	163	139	118	101	87	...	224	218	208	197	186	176	166	157	148	139	131	123	116	109
	7/8	15.96	54.4	1.11	2.97	239	239	233	218	203	188	174	148	126	108	93	...	239	233	222	211	200	189	178	168	158	149	140	132	124	117
7 × 3½	3/8	7.60	26.0	.96	3.50	114	112	104	96	88	80	73	61	51	42	...	...	114	114	113	108	104	99	95	91	86	82	78	74	70	67
	7/16	8.80	30.0	.95	3.51	132	130	120	111	101	92	84	69	58	...	...	...	132	132	131	126	120	115	110	105	100	95	90	86	82	78
	1/2	10.00	34.0	.94	3.53	150	147	135	125	114	104	94	78	65	...	...	...	150	150	149	143	137	131	126	120	114	109	103	98	93	89
	9/16	11.18	38.2	.93	3.54	168	163	151	139	126	115	105	86	72	...	...	...	168	168	167	160	154	147	141	134	128	122	116	110	105	100
	5/8	12.34	42.0	.93	3.55	185	180	167	153	140	127	115	95	79	...	...	...	185	185	184	177	170	163	155	148	141	135	128	122	116	110
	11/16	13.50	46.0	.92	3.57	203	197	181	166	152	138	125	103	85	...	...	...	203	203	202	194	186	178	171	163	155	148	141	134	127	121
	3/4	14.62	49.8	.91	3.58	219	212	195	179	163	148	134	110	91	...	...	...	219	219	219	211	202	194	185	177	169	161	153	145	138	132
	13/16	15.74	53.6	.91	3.59	236	228	210	192	175	159	144	119	98	...	...	...	236	236	236	227	218	209	200	190	182	173	165	157	149	142
	7/8	16.84	57.4	.90	3.60	253	243	224	204	186	168	153	125	103	...	...	...	253	253	253	243	233	224	214	204	195	186	177	168	160	153
	15/16	17.94	61.0	.89	3.62	269	258	237	216	196	178	161	132	108	...	...	...	269	269	269	260	249	239	229	218	208	199	189	180	172	163
	1"	19.00	64.6	.89	3.63	285	273	251	229	208	188	170	139	115	...	...	...	285	285	285	275	264	253	242	232	221	211	201	191	182	173
8 × 6	7/16	11.86	40.4	1.80	3.68	178	178	178	178	178	178	171	158	144	130	119	108	178	178	178	173	166	159	153	146	139	133	127	121	115	110
	1/2	13.50	46.0	1.79	3.69	202	202	202	202	202	202	195	179	163	148	134	122	203	203	203	197	189	182	174	166	159	152	145	138	131	125
	9/16	15.12	51.4	1.78	3.71	227	227	227	227	227	226	217	200	182	165	150	135	227	227	227	221	212	204	195	187	179	171	163	155	148	141
	5/8	16.72	57.0	1.77	3.71	251	251	251	251	251	249	239	221	200	183	165	148	251	251	251	244	235	226	216	207	198	189	180	172	164	156
	11/16	18.30	62.4	1.77	3.72	275	275	275	275	275	273	262	241	219	199	180	163	275	275	275	268	257	247	237	227	217	207	197	188	180	171
	3/4	19.88	67.6	1.76	3.73	298	298	298	298	298	297	285	260	238	215	194	177	298	298	298	291	280	269	258	247	236	225	215	205	195	186
	13/16	21.44	73.0	1.75	3.75	322	322	322	322	322	319	306	280	255	231	209	189	322	322	322	314	303	291	279	267	255	244	233	222	212	202
	7/8	22.96	78.2	1.74	3.76	344	344	344	344	344	340	327	299	272	247	223	201	344	344	344	337	324	312	299	286	274	262	250	238	227	217
	15/16	24.50	83.4	1.73	3.77	368	368	368	368	368	363	348	319	289	262	236	213	368	368	368	360	347	333	319	306	293	280	267	255	243	232
	1"	26.00	88.4	1.73	3.78	390	390	390	390	390	385	369	338	307	278	251	226	390	390	390	382	368	354	340	325	311	297	284	271	259	247

Lengths in the Axis X-X and Axis Y-Y columns are Unsupported Length in Feet.

LOADS BY A. I. S. C. SPECIFICATION

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO UNEQUAL ANGLES

LONG LEGS BACK TO BACK

Loads to right of heavy vertical lines are for Secondary Members ONLY.

3/8" BACK TO BACK

Size	Thickness	Two Angles Area	Two Angles Weight	Radius of Gyration X-X	Radius of Gyration Y-Y	AXIS X-X Unsupported Length in Feet 4	5	6	7	8	9	10	12	14	16	18	20	22	AXIS Y-Y Unsupported Length in Feet 4	5	6	7	8	9	10	12	14	16	18	20	22
2½ × 2	3/16	1.62	5.5	.79	.92	24	22	20	18	16	14	13	10	...	...	...	...	...	24	24	22	20	18	17	15	12	10				
	1/4	2.12	7.2	.78	.93	32	29	26	23	21	19	17	13	...	...	...	...	...	32	31	29	26	24	22	20	16	14				
	5/16	2.62	9.0	.78	.95	39	36	32	29	26	23	20	16	...	...	...	...	...	39	39	36	33	30	27	25	21	17				
3 × 2½	1/4	2.62	9.0	.95	1.13	39	39	36	33	30	28	25	20	17	...	...	...	...	39	39	38	36	34	31	29	25	21	18	16		
	5/16	3.24	11.2	.94	1.14	49	48	44	40	37	34	31	25	21	...	...	...	...	49	49	48	45	42	39	36	31	26	23	19		
	3/8	3.84	13.2	.93	1.16	58	56	52	48	43	40	36	30	25	...	...	...	...	58	58	57	53	50	47	43	37	32	27	24		
	7/16	4.42	15.2	.92	1.17	66	64	59	54	50	45	41	34	28	...	...	...	...	66	66	66	62	58	54	50	43	37	32	27		
3½ × 2½	1/4	2.88	9.8	1.12	1.09	43	43	42	39	37	34	32	27	23	20	17	...	...	43	43	42	39	36	34	31	26	22	19	16		
	5/16	3.56	12.2	1.11	1.10	53	53	52	49	45	42	39	33	28	24	21	...	...	53	53	52	48	45	42	39	33	28	24	20		
	3/8	4.22	14.4	1.10	1.11	63	63	61	57	53	50	46	39	33	28	24	..	...	63	63	62	58	54	50	46	39	33	29	24		
	7/16	4.86	16.6	1.09	1.12	73	73	70	66	61	57	52	44	38	32	26	...	...	73	73	71	67	62	58	53	46	39	33	29		
	1/2	5.50	18 8	1.09	1.13	83	83	80	75	69	64	59	50	43	36	31	...	...	83	83	81	76	71	66	61	52	44	38	33		
4 × 3	5/16	4.18	14.4	1.27	1.30	63	63	63	61	57	54	50	44	38	33	29	25	...	63	63	63	61	58	54	51	45	39	34	30	26	
	3/8	4.96	17.0	1.26	1.31	74	74	74	72	68	63	59	52	45	39	34	30	...	74	74	74	73	69	65	61	53	47	41	36	31	
	7/16	5.74	19.6	1.25	1.32	86	86	86	83	78	73	68	60	52	45	39	34	...	86	86	86	84	80	75	71	62	54	47	42	36	32
	1/2	6.50	22.2	1.25	1.33	98	98	98	94	88	83	77	67	58	51	44	38	...	98	98	98	96	91	86	81	71	62	54	47	42	37
	9/16	7.24	24.8	1.24	1.35	109	109	109	104	98	92	86	75	65	56	49	42	...	109	109	109	107	102	96	91	80	70	61	54	47	42
	5/8	7.96	27.2	1.23	1.36	119	119	119	114	107	100	94	81	70	61	53	46	...	119	119	119	118	112	106	100	88	78	68	60	52	46
4 × 3½	5/16	4.50	15.4	1.26	1.55	68	68	68	65	61	58	54	47	41	35	31	27	...	68	68	68	68	67	64	61	55	49	44	39	35	31
	3/8	5.34	18.2	1.25	1.56	80	80	80	77	72	68	64	55	48	42	36	32	...	80	80	80	80	79	76	72	65	58	52	47	41	37
	7/16	6.18	21.2	1.24	1.57	93	93	93	89	83	78	73	64	55	48	41	36	...	93	93	93	93	92	88	84	76	68	61	54	48	43
	1/2	7.00	23.8	1.23	1.58	105	105	105	100	94	88	82	72	62	54	46	40	...	105	105	105	105	105	100	95	86	77	69	62	55	49
	9/16	7.80	26.6	1.23	1.59	117	117	117	112	105	98	92	80	69	60	52	45	...	117	117	117	117	117	112	107	96	87	78	69	62	55
	5/8	8.60	29.4	1.22	1.60	129	129	129	123	115	108	101	87	75	65	56	49	...	129	129	129	129	129	123	118	107	96	86	77	69	62
	11/16	9 36	32.0	1.21	1.62	140	140	140	133	125	117	109	94	81	70	61	53	...	140	140	140	140	140	135	129	117	105	95	85	76	68
	3/4	10.12	34.6	1.20	1.63	152	152	152	143	134	126	117	101	87	75	65	57	...	152	152	152	152	152	146	140	127	115	103	92	83	74
5 × 3	5/16	4.80	16.4	1.61	1.22	72	72	72	72	72	69	66	60	54	48	43	39	35	72	72	72	68	64	60	56	49	42	36	32	27	
	3/8	5.72	19.6	1.61	1.23	86	86	86	86	86	82	79	71	64	57	51	46	41	86	86	86	82	77	72	67	59	51	44	38	33	
	7/16	6.62	22.6	1.60	1.24	99	99	99	99	99	95	91	82	74	66	59	53	47	99	99	99	95	89	84	78	68	59	51	44	39	
	1/2	7.50	25.6	1.59	1.25	113	113	113	113	112	107	103	93	83	75	67	60	53	113	113	113	108	102	95	89	78	67	58	51	44	
	9/16	8.36	28.6	1.58	1.26	125	125	125	125	125	119	114	103	92	83	74	66	59	125	125	125	121	114	107	100	87	76	66	57	50	
	5/8	9.22	31.4	1.57	1.28	138	138	138	138	137	131	125	113	101	91	81	72	64	138	138	138	134	126	119	112	98	85	74	64	56	
	11/16	10.06	34.2	1.56	1.29	151	151	151	151	150	143	136	123	110	98	88	78	70	151	151	151	147	138	130	122	107	93	81	71	62	
	3/4	10.88	37.0	1.55	1.31	163	163	163	163	161	154	147	132	118	106	94	84	75	163	163	163	159	151	142	134	117	102	89	78	68	
5 × 3½	5/16	5.12	17.4	1.61	1.45	77	77	77	77	77	74	70	64	57	51	46	41	37	77	77	77	77	74	71	67	60	53	47	41	37	
	3/8	6.10	20.8	1.60	1.46	92	92	92	92	92	88	84	76	68	61	55	49	44	92	92	92	92	89	84	80	71	63	56	50	44	
	7/16	7.06	24.0	1.59	1.47	106	106	106	106	106	101	97	87	78	70	63	56	50	106	106	106	106	103	98	93	83	74	65	58	51	
	1/2	8.00	27.2	1.58	1.49	120	120	120	120	120	114	109	99	88	79	71	63	56	120	120	120	120	117	112	106	95	84	75	66	59	
	9/16	8.94	30.4	1.57	1.50	134	134	134	134	133	127	121	110	98	88	78	70	62	134	134	134	134	131	125	119	107	95	84	75	66	
	5/8	9.84	33.6	1.56	1.51	148	148	148	148	146	140	133	120	108	96	86	76	68	148	148	148	148	145	138	131	118	105	93	83	74	
	11/16	10.74	36.6	1.56	1.52	161	161	161	161	160	153	146	131	118	105	94	83	75	161	161	161	161	158	151	144	129	115	103	91	81	
	3/4	11.62	39.6	1.55	1.54	174	174	174	174	172	165	157	141	127	113	101	90	80	174	174	174	174	172	164	156	141	126	112	100	89	

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO UNEQUAL ANGLES

LONG LEGS BACK TO BACK

Loads to right of heavy vertical lines are for Secondary Members ONLY.

3/8" BACK TO BACK

AXIS Y-Y

Size	Thickness	Two Angles		Radius of Gyration		AXIS X - X, Unsupported Length in Feet												AXIS Y - Y, Unsupported Length in Feet													
		Area	Weight	X-X	Y-Y	9	10	12	14	16	18	20	22	24	26	28	30	6	7	8	9	10	12	14	16	18	20	22	24	26	28
6 × 3½	3/8	6.84	23.4	1.94	1.39	103	102	94	87	80	73	67	61	55	50	46	...	103	102	97	92	87	77	68	60	53	46	41			
	7/16	7.94	27.0	1.93	1.40	119	118	109	101	92	84	77	70	64	58	53	...	119	119	113	107	102	90	79	70	62	54	48			
	1/2	9.00	30.6	1.92	1.41	135	133	123	114	104	95	87	79	72	66	60	...	135	135	129	122	116	103	91	80	70	62	55			
	9/16	10.06	34.2	1.91	1.42	151	148	138	127	116	106	96	88	80	73	67	...	151	151	144	137	130	115	102	90	79	70	62			
	5/8	11.10	37.8	1.90	1.43	167	164	152	139	127	116	106	96	88	80	73	...	167	167	160	152	144	128	113	100	88	78	69			
	11/16	12.12	41.2	1.89	1.45	182	178	165	152	139	126	115	105	95	87	79	...	182	182	175	167	158	141	125	110	98	87	77			
	3/4	13.12	44.8	1.89	1.46	197	193	179	164	150	137	125	113	103	94	86	...	197	197	190	181	172	153	136	120	107	94	84			
	13/16	14.12	48.0	1.88	1.48	212	207	192	176	161	147	133	121	110	101	92	...	212	212	206	196	186	167	148	131	116	103	92			
	7/8	15.10	51.4	1.87	1.49	227	221	205	188	172	156	142	129	117	107	97	...	227	227	221	211	200	179	159	141	125	111	99			
6 × 4	3/8	7.22	24.6	1.93	1.62	108	107	99	91	84	77	70	64	58	53	48	...	108	108	108	104	100	90	81	73	65	59	53	47		
	7/16	8.36	28.6	1.92	1.63	125	124	115	106	97	88	81	73	67	61	56	...	125	125	125	121	116	105	95	85	76	68	61	55		
	1/2	9.50	32.4	1.91	1.65	143	140	130	120	110	100	91	83	76	69	63	...	143	143	143	138	132	120	109	98	88	79	71	64		
	9/16	10.62	36.2	1.90	1.66	159	156	145	133	122	111	101	92	84	77	70	...	159	159	159	155	148	135	122	110	98	88	80	72		
	5/8	11.72	40.0	1.90	1.67	176	173	160	147	135	123	112	102	93	85	77	...	176	176	176	171	164	149	135	122	109	98	88	80		
	11/16	12.80	43.6	1.89	1.68	192	188	174	160	146	134	121	111	101	92	84	...	192	192	192	187	180	164	148	134	120	108	97	87		
	3/4	13.88	47.2	1.88	1.69	208	204	188	173	158	144	131	119	108	99	90	...	208	208	208	204	195	178	161	146	131	118	106	96		
	13/16	14.94	50.8	1.87	1.70	224	219	202	186	170	155	141	128	116	106	96	...	224	224	224	220	211	192	174	158	142	128	115	104		
	7/8	15.96	54.4	1.86	1.71	239	233	215	198	181	164	149	136	123	112	102	...	239	239	239	235	226	206	187	169	152	137	124	112		
7 × 3½	3/8	7.60	26.0	2.27	1.33	114	114	112	105	98	91	84	78	72	67	62	57	114	112	106	100	94	83	72	63	55	49	43			
	7/16	8.80	30.0	2.26	1.34	132	132	129	121	113	105	97	90	83	77	71	66	132	130	123	116	110	96	85	74	65	57	50			
	1/2	10.00	34.0	2.25	1.35	150	150	147	137	128	119	110	102	94	87	80	74	150	148	141	133	125	110	97	85	74	65	58			
	9/16	11.18	38.2	2.25	1.36	168	168	164	154	143	133	123	114	105	97	90	83	168	166	158	149	140	124	109	96	84	74	65			
	5/8	12.34	42.0	2.24	1.37	185	185	181	169	158	146	136	125	116	107	99	91	185	184	175	165	156	138	121	106	93	82	72			
	11/16	13.50	46.0	2.23	1.39	203	203	197	185	172	160	148	137	126	116	107	99	203	202	192	182	172	152	134	118	104	92	81			
	3/4	14.62	49.8	2.22	1.40	219	219	213	200	186	173	160	147	136	125	116	107	219	219	209	198	187	166	146	129	113	100	88			
	13/16	15.74	53.6	2.21	1.41	236	236	229	215	200	185	171	158	146	134	124	115	236	236	225	214	202	179	158	140	123	109	96			
	7/8	16.84	57.4	2.20	1.42	253	253	245	229	213	197	183	168	155	143	132	122	253	253	242	229	217	193	170	150	133	117	104			
	15/16	17.94	61.0	2.19	1.44	269	269	260	243	226	210	194	179	165	152	140	129	269	269	259	246	233	208	184	162	144	127	113			
	1"	19.00	64.6	2.19	1.45	285	285	276	258	240	222	205	189	174	161	148	137	285	285	275	261	248	221	196	173	153	136	121			
8 × 6	7/16	11.86	40.4	2.57	2.43	178	178	178	173	163	153	144	135	126	117	110	102	178	178	178	178	178	178	169	158	148	138	129	120	111	104
	1/2	13.50	46.0	2.56	2.44	203	203	203	196	185	174	163	153	143	133	124	116	203	203	203	203	203	203	192	181	169	158	147	137	127	118
	9/16	15.12	51.4	2.55	2.46	227	227	227	219	208	195	182	171	159	148	138	129	227	227	227	227	227	227	216	203	191	178	166	155	144	134
	5/8	16.72	57.0	2.54	2.46	251	251	251	242	228	215	201	188	176	164	153	142	251	251	251	251	251	251	239	225	211	197	184	171	159	148
	11/16	18.30	62.4	2.54	2.47	275	275	275	265	250	235	220	206	192	179	167	156	275	275	275	275	275	275	262	247	231	216	202	188	175	162
	3/4	19.88	67.6	2.53	2.48	298	298	298	287	271	255	239	223	208	194	181	168	298	298	298	298	298	298	285	268	252	235	220	205	191	177
	13/16	21.44	73.0	2.52	2.49	322	322	322	309	292	274	257	240	224	208	194	181	322	322	322	322	322	322	308	290	272	255	238	222	206	192
	7/8	22.96	78.2	2.51	2.51	344	344	344	331	312	293	274	256	239	223	207	193	344	344	344	344	344	344	331	312	293	274	256	239	223	207
	15/16	24.50	83.4	2.50	2.51	368	368	368	353	332	311	292	272	254	236	220	205	368	368	368	368	368	368	353	333	312	293	273	255	237	221
	1"	26.00	88.4	2.49	2.52	390	390	390	374	352	330	309	288	269	250	233	217	390	390	390	390	390	390	375	354	332	311	291	271	253	235

LOADS BY A. I. S. C. SPECIFICATION

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO UNEQUAL ANGLES

SHORT LEGS BACK TO BACK

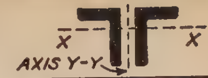
Loads to right of heavy vertical lines are for Secondary Members ONLY.

AXIS Y-Y

1/2" BACK TO BACK

Size	Thickness	Two Angles Area	Two Angles Weight	Radius of Gyration X-X	Radius of Gyration Y-Y	AXIS X-X Unsupported Length in Feet 4	5	6	7	8	9	10	12	14	16	18	20	AXIS Y-Y Unsupported Length in Feet 14	16	18	20	22	24	26	28	30	32	34	36	38	40
6 × 3½	3/8	6.84	23.4	.99	3.00	103	102	95	88	81	74	68	57	47	40	...	...	103	100	96	91	86	81	77	73	68	64	61	57	54	51
	7/16	7.94	27.0	.98	3.01	119	118	110	102	93	85	78	65	54	46	...	...	119	116	111	105	100	94	89	84	80	75	71	66	63	59
	1/2	9.00	30.6	.97	3.02	135	133	124	114	105	98	87	73	61	51	...	...	135	132	126	120	114	108	102	96	91	85	80	76	71	67
	9/16	10.06	34.2	.96	3.04	151	149	138	127	116	106	97	80	67	56	...	...	151	148	141	135	128	121	114	108	102	96	90	85	80	76
	5/8	11.10	37.8	.96	3.05	167	164	152	140	128	117	107	89	74	62	...	...	167	164	156	149	141	134	126	119	113	106	100	94	89	84
	11/16	12.12	41.2	.95	3.06	182	179	165	152	139	127	116	96	80	...	...	...	182	179	171	163	154	146	138	131	123	116	110	104	98	92
	3/4	13.12	44.8	.94	3.08	197	193	178	164	149	136	124	102	85	...	...	...	197	194	186	177	168	159	150	142	134	127	120	113	107	100
	13/16	14.12	48.0	.94	3.09	212	207	192	176	161	147	133	110	92	...	...	...	212	209	200	190	181	171	162	153	145	137	129	122	115	109
	7/8	15.10	51.4	.93	3.10	227	221	204	187	171	155	141	117	97	...	...	...	227	224	214	204	194	184	174	164	155	147	138	131	123	117
6 × 4	3/8	7.22	24.6	1.17	2.92	108	108	107	101	95	88	82	71	60	52	45	...	108	105	100	95	89	84	79	75	70	66	62	59	55	52
	7/16	8.36	28.6	1.16	2.93	125	125	124	117	109	102	95	81	69	59	50	...	125	121	115	110	104	98	92	87	82	77	72	68	64	60
	1/2	9.50	32.4	1.15	2.95	142	142	140	132	124	115	107	92	78	67	58	...	142	139	132	125	118	112	105	99	94	88	83	78	73	69
	9/16	10.62	36.2	1.14	2.96	159	159	157	147	137	127	119	102	87	74	64	...	159	155	148	140	133	126	118	111	105	99	93	88	82	78
	5/8	11.72	40.0	1.13	2.97	176	176	172	162	150	139	130	111	94	81	70	...	176	171	163	155	147	139	131	123	116	110	103	97	91	86
	11/16	12.80	43.6	1.13	2.98	192	192	188	176	164	153	142	121	103	88	76	...	191	187	178	169	161	152	143	135	127	120	113	106	100	94
	3/4	13.88	47.2	1.12	2.99	208	208	203	190	177	165	153	130	111	95	81	...	208	203	194	184	174	165	156	147	138	131	123	116	109	102
	13/16	14.94	50.8	1.11	3.00	224	224	218	204	190	176	163	139	118	101	87	...	224	219	209	198	188	178	168	159	149	141	133	125	118	111
	7/8	15.96	54.4	1.11	3.02	239	239	233	218	203	188	174	148	126	108	93	...	239	235	224	213	202	191	180	170	161	151	143	134	127	120
7 × 3½	3/8	7.60	26.0	.96	3.55	114	112	104	96	88	80	73	61	51	42	...	...	114	114	113	109	105	100	96	90	87	83	79	75	71	68
	7/16	8.80	30.0	.95	3.56	132	130	120	111	101	92	84	69	58	...	...	...	132	132	131	127	121	116	111	106	101	96	92	87	83	79
	1/2	10.00	34.0	.94	3.58	150	147	135	125	114	104	94	78	65	...	...	...	150	150	150	144	138	133	127	121	115	110	105	99	95	90
	9/16	11.18	38.2	.93	3.59	168	163	151	139	126	115	105	86	72	...	...	...	168	168	168	161	155	148	142	135	129	124	117	112	106	101
	5/8	12.34	42.0	.93	3.60	185	180	167	153	140	127	115	95	79	...	...	...	185	185	185	178	171	164	157	150	143	136	130	123	117	112
	11/16	13.50	46.0	.92	3.61	203	197	181	166	152	138	125	103	85	...	...	...	203	203	203	195	187	180	172	164	156	149	142	135	129	123
	3/4	14.62	49.8	.91	3.63	219	212	195	179	163	148	134	110	91	...	...	...	219	219	219	212	203	195	187	178	170	162	155	147	140	133
	13/16	15.74	53.6	.91	3.64	236	228	210	192	175	159	144	119	98	...	...	...	236	236	236	228	219	210	201	192	184	175	167	159	151	144
	7/8	16.84	57.4	.90	3.65	253	243	224	204	186	168	153	125	103	...	...	...	253	253	253	244	235	225	216	206	197	188	179	170	162	155
	15/16	17.94	61.0	.89	3.67	269	258	237	216	196	178	161	132	108	...	...	...	269	269	269	261	251	241	230	220	210	201	191	182	174	166
	1"	19.00	64.6	.89	3.68	285	273	251	229	208	188	170	139	115	...	...	...	285	285	285	277	266	255	244	234	223	213	203	194	185	176
8 × 6	7/16	11.86	40.4	1.80	3.73	178	178	178	178	178	178	171	158	144	130	119	108	178	178	178	174	167	161	154	147	141	134	128	122	117	111
	1/2	13.50	46.0	1.79	3.74	202	202	202	202	202	202	195	179	163	148	134	122	202	202	202	198	190	183	175	168	160	153	146	139	133	127
	9/16	15.12	51.4	1.78	3.75	227	227	227	227	227	226	217	200	182	165	150	135	227	227	227	222	213	205	197	188	180	172	164	157	149	142
	5/8	16.72	57.0	1.77	3.76	251	251	251	251	251	249	239	221	200	183	165	148	251	251	251	245	236	226	218	209	199	191	182	174	166	158
	11/16	18.30	62.4	1.77	3.77	275	275	275	275	275	273	262	241	219	199	180	163	275	275	275	269	259	249	239	229	219	209	199	191	182	173
	3/4	19.88	67.6	1.76	3.78	298	298	298	298	298	297	285	260	238	215	194	177	298	298	298	293	282	271	260	248	238	227	217	208	198	189
	13/16	21.44	73.0	1.75	3.79	322	322	322	322	322	319	306	280	255	231	209	189	322	322	322	316	304	292	280	269	257	246	235	224	214	204
	7/8	22.96	78.2	1.74	3.81	344	344	344	344	344	340	327	299	272	247	223	201	344	344	344	339	326	314	301	289	276	264	253	241	230	220
	15/16	24.50	83.4	1.73	3.81	368	368	368	368	368	363	348	319	289	262	236	213	368	368	368	361	348	335	321	308	295	282	270	257	245	234
	1"	26.00	88.4	1.73	3.82	390	390	390	390	390	385	369	338	307	278	251	226	390	390	390	384	370	356	341	327	313	300	287	274	261	249

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR STRUTS OF TWO UNEQUAL ANGLES



1/2" BACK TO BACK

LONG LEGS BACK TO BACK

Loads to right of heavy vertical lines are for Secondary Members ONLY.

Size	Thickness	Two Angles		Radius of Gyration		AXIS X - X: Unsupported Length in Feet												AXIS Y - Y: Unsupported Length in Feet												
		Area	Weight	X-X	Y-Y	9	10	12	14	16	18	20	22	24	26	28	30	6	7	8	9	10	12	14	16	18	20	22	24	26	28
6 × 3½	3/8	6.84	23.4	1.94	1.43	103	102	94	87	80	73	67	61	55	50	46	...	103	103	99	94	89	79	70	62	54	48	43			
	7/16	7.94	27.0	1.93	1.44	119	118	109	101	92	84	77	70	64	58	53	...	119	119	115	109	103	92	81	72	64	56	50			
	1/2	9.00	30.6	1.92	1.46	135	133	123	114	104	95	87	79	72	66	60	...	135	135	131	124	118	105	93	83	73	65	58			
	9/16	10.06	34.2	1.91	1.47	151	148	138	127	116	106	96	88	80	73	67	...	151	151	146	139	132	118	105	93	82	73	65			
	5/8	11.10	37.8	1.90	1.48	167	164	152	139	127	116	106	96	88	80	73	...	167	167	162	154	146	131	116	103	92	81	72			
	11/16	12.12	41.2	1.89	1.49	182	178	165	152	139	126	115	105	95	87	79	...	182	182	177	169	160	144	128	113	101	89	80			
	3/4	13.12	44.8	1.89	1.51	197	193	179	164	150	137	125	113	103	94	86	...	197	197	193	184	175	157	140	124	111	98	88			
	13/16	14.12	48.0	1.88	1.52	212	207	192	176	161	147	133	121	110	101	92	...	212	212	208	199	189	170	151	135	120	107	95			
	7/8	15.10	51.4	1.87	1.53	227	221	205	188	172	156	142	129	117	107	97	...	227	227	223	213	203	182	163	145	129	115	102			
6 × 4	3/8	7.22	24.6	1.93	1.67	108	107	99	91	84	77	70	64	58	53	48	...	108	108	108	106	101	92	83	75	67	61	54	49		
	7/16	8.36	28.6	1.92	1.68	125	124	115	106	97	88	81	73	67	61	56	...	125	125	125	122	117	107	97	87	78	71	64	57		
	1/2	9.50	32.4	1.91	1.69	143	140	130	120	110	100	91	83	76	69	63	...	143	143	143	139	134	122	110	100	90	81	73	65		
	9/16	10.62	36.2	1.90	1.70	159	156	145	133	122	111	101	92	84	77	70	...	159	159	159	156	150	137	124	112	101	91	82	74		
	5/8	11.72	40.0	1.90	1.71	176	173	160	147	135	123	112	102	93	85	77	...	176	176	176	173	166	151	137	124	112	101	91	82		
	11/16	12.80	43.6	1.89	1.73	192	188	174	160	146	134	121	111	101	92	84	...	192	192	192	189	182	166	151	137	124	111	101	91		
	3/4	13.88	47.2	1.88	1.74	208	204	188	173	158	144	131	119	108	99	90	...	208	208	208	206	198	181	165	149	135	122	110	99	90	
	13/16	14.94	50.8	1.87	1.75	224	219	202	186	170	155	141	128	116	106	96	...	224	224	224	222	213	195	178	161	146	132	119	107	97	
	7/8	15.96	54.4	1.86	1.76	239	233	215	198	181	164	149	136	123	112	102	...	239	239	239	238	228	209	191	173	156	141	128	116	105	
7 × 3½	3/8	7.60	26.0	2.27	1.37	114	114	112	105	98	91	84	78	72	67	62	57	114	113	108	102	96	85	75	65	58	51	45			
	7/16	8.80	30.0	2.26	1.38	132	132	129	121	113	105	97	90	83	77	71	66	132	131	125	118	112	99	87	76	67	59	52			
	1/2	10.00	34.0	2.25	1.39	150	150	147	137	128	119	110	102	94	87	80	74	150	150	142	135	127	113	99	87	77	68	60			
	9/16	11.18	38.2	2.25	1.41	168	168	164	154	143	133	123	114	105	97	90	83	168	168	160	152	144	128	113	99	87	77	68			
	5/8	12.34	42.0	2.24	1.42	185	185	181	169	158	146	136	125	116	107	99	91	185	185	177	168	159	141	125	110	97	86	76			
	11/16	13.50	46.0	2.23	1.43	203	203	197	185	172	160	148	137	126	116	107	99	203	203	194	185	175	155	138	121	107	95	84			
	3/4	14.62	49.8	2.22	1.45	219	219	213	200	186	173	160	147	136	125	116	107	219	219	212	201	191	170	151	133	118	104	93			
	13/16	15.74	53.6	2.21	1.46	236	236	229	215	200	185	171	158	146	134	124	115	236	236	228	217	206	184	163	144	128	113	101			
	7/8	16.84	57.4	2.20	1.47	253	253	245	229	213	197	183	168	155	143	132	122	253	253	245	233	221	198	176	156	138	122	109			
	15/16	17.94	61.0	2.19	1.49	269	269	260	243	226	210	194	179	165	152	140	129	269	269	262	250	237	213	189	168	149	132	118			
	1"	19.00	64.6	2.19	1.50	285	285	276	258	240	222	205	189	174	161	148	137	285	285	279	266	252	226	202	179	159	141	126			
8 × 6	7/16	11.86	40.4	2.57	2.48	178	178	178	173	163	153	144	135	126	117	110	102	178	178	178	178	178	178	170	160	150	140	131	122	114	106
	1/2	13.50	46.0	2.56	2.48	203	203	203	196	185	174	163	153	143	133	124	116	203	203	203	203	203	203	194	182	171	160	149	139	129	120
	9/16	15.12	51.4	2.55	2.50	227	227	227	219	208	195	182	171	159	148	138	129	227	227	227	227	227	227	218	205	192	180	168	157	146	136
	5/8	16.72	57.0	2.54	2.51	251	251	251	242	228	215	201	188	176	164	153	142	251	251	251	251	251	251	241	227	213	200	186	174	162	151
	11/16	18.30	62.4	2.54	2.52	275	275	275	265	250	235	220	206	192	179	167	156	275	275	275	275	275	275	264	249	234	219	205	191	178	166
	3/4	19.88	67.6	2.53	2.52	298	298	298	287	271	255	239	223	208	194	181	168	298	298	298	298	298	298	287	271	254	238	222	207	193	180
	13/16	21.44	73.0	2.52	2.54	322	322	322	309	292	274	257	240	224	208	194	181	322	322	322	322	322	322	310	293	275	258	241	225	210	196
	7/8	22.96	78.2	2.51	2.55	344	344	344	331	312	293	274	256	239	223	207	193	344	344	344	344	344	344	333	316	295	277	259	242	225	210
	15/16	24.50	83.4	2.50	2.56	368	368	368	353	332	311	292	272	254	236	220	205	368	368	368	368	368	368	356	336	316	296	277	259	242	225
	1"	26.00	88.4	2.49	2.57	390	390	390	374	352	330	309	288	269	250	233	217	390	390	390	390	390	390	378	357	336	315	295	276	257	240

LOADS BY A. I. S. C. SPECIFICATION

ALLOWABLE UNIFORM LOAD IN KIPS FOR STANDARD ANGLES USED AS BEAMS

Position	Angle Size	Angle Thickness	Angle Weight per foot	Coef. of Strength	Length in Span in feet. Laterally supported. 3	4	5	6	7	8	9	10	11	12	13	14
Equal Legs	2½ × 2½	¼	4.1	4719	1.57	1.18	.94	.79	.67	.59	.52	.47	.43			
		5/16	5.0	5795	1.93	1.45	1.16	.97	.83	.72	.64	.58	.53			
	3 × 3	¼	4.9	6889	2.30	1.72	1.38	1.15	.98	.86	.77	.69	.63	.57		
		3/16	6.1	8507	2.84	2.13	1.70	1.42	1.22	1.06	.95	.35	.77	.71		
	3½ × 3½	5/16	7.2	11713	3.90	2.93	2.34	1.95	1.67	1.46	1.30	1.17	1.06	.98		
		⅜	8.5	13831	4.61	3.46	2.77	2.31	1.98	1.73	1.54	1.38	1.26	1.15		
	4 × 4	5/16	8.2	15458	5.15	3.86	3.09	2.58	2.21	1.93	1.72	1.55	1.41	1.29	1.19	
		⅜	9.8	18294	6.10	4.57	3.66	3.05	2.61	2.29	2.03	1.83	1.66	1.52	1.41	
	6 × 6	⅜	14.9	42358	14.12	10.59	8.47	7.06	6.05	5.29	4.71	4.24	3.85	3.53	3.26	3.03
		½	19.6	55305	18.44	13.83	11.06	9.22	7.90	6.91	6.15	5.53	5.03	4.62	4.25	3.95
Long Leg Up	3 × 2½	¼	4.5	6718	2.24	1.68	1.34	1.12	.96	.84	.75	.67	.61			
		5/16	5.6	8231	2.74	2.06	1.65	1.37	1.18	1.03	.91	.82	.75			
	3½ × 2½	¼	4.9	9038	3.01	2.26	1.81	1.51	1.29	1.13	1.00	.90	.82	.75		
		5/16	6.1	11136	3.71	2.78	2.23	1.86	1.59	1.39	1.24	1.11	1.01	.93		
	4 × 3	5/16	7.2	14802	4.93	3.70	2.96	2.47	2.11	1.85	1.64	1.48	1.35	1.23	1.14	
		⅜	8.5	17471	5.82	4.37	3.49	2.91	2.50	2.18	1.94	1.75	1.59	1.46	1.34	
	4 × 3½	5/16	7.7	15149	5.05	3.79	3.03	2.52	2.16	1.89	1.68	1.51	1.38	1.26	1.17	
		⅜	9.1	17978	5.99	4.49	3.60	3.00	2.57	2.25	2.00	1.80	1.63	1.50	1.38	
	5 × 3	5/16	8.2	22626	7.54	5.66	4.53	3.77	3.23	2.83	2.51	2.26	2.06	1.89	1.74	1.62
		⅜	9.8	26800	8.93	6.70	5.36	4.47	3.83	3.35	2.98	2.68	2.44	2.23	2.06	1.91
	5 × 3½	5/16	8.7	23226	7.74	5.81	4.65	3.87	3.32	2.90	2.58	2.32	2.11	1.94	1.79	1.66
		⅜	10.4	27540	9.18	6.89	5.51	4.59	3.93	3.44	3.06	2.75	2.50	2.30	2.12	1.97
	6 × 4	⅜	12.3	39813	13.27	9.95	7.96	6.64	5.69	4.98	4.42	3.98	3.62	3.32	3.06	2.84
		½	16.2	52070	17.36	13.02	10.41	8.68	7.44	6.51	5.79	5.21	4.73	4.34	4.01	3.72
Short Leg Up	3 × 2½	¼	4.5	4826	1.61	1.21	.96	.80	.69	.60	.54	.48	.44			
		5/16	5.6	5934	1.98	1.48	1.19	.99	.85	.74	.66	.59	.54			
	3½ × 2½	¼	4.9	4952	1.65	1.24	.99	.83	.71	.62	.55	.50	.45	.41		
		5/16	6.1	6064	2.02	1.52	1.21	1.01	.87	.76	.67	.61	.55	.51		
	4 × 3	5/16	7.2	8839	2.95	2.21	1.77	1.47	1.26	1.10	.98	.88	.80	.74	.68	
		⅜	8.5	10378	3.46	2.59	2.08	1.73	1.48	1.30	1.15	1.04	.94	.36	.80	
	4 × 3½	5/16	7.7	11907	3.97	2.98	2.38	1.98	1.70	1.49	1.32	1.19	1.08	.99	.92	
		⅜	9.1	14126	4.71	3.53	2.83	2.35	2.02	1.77	1.57	1.41	1.28	1.18	1.09	
	5 × 3	5/16	8.2	9052	3.02	2.26	1.81	1.51	1.29	1.13	1.01	.91	.82	.75	.70	
		⅜	9.8	10643	3.55	2.66	2.13	1.77	1.52	1.33	1.18	1.06	.97	.89	.82	
	5 × 3½	⅜	10.4	12271	4.09	3.07	2.45	2.05	1.75	1.53	1.36	1.23	1.12	1.02	.94	
		7/16	12.0	14454	4.82	3.61	2.89	2.41	2.06	1.81	1.61	1.45	1.31	1.20	1.11	
	6 × 4	⅜	12.3	19216	6.41	4.80	3.84	3.20	2.75	2.40	2.14	1.92	1.75	1.60	1.48	1.37
		½	16.2	24997	8.33	6.25	5.00	4.17	3.57	3.12	2.78	2.50	2.27	2.08	1.92	1.79

For Loads for Spans not tabulated divide the Coefficient of Strength by the Span in feet.

Part IV

Section 3

American Standard Channels

Dimensions

Technical Functions

Allowable Total Loads
by
A. I. S. C. Specification

Connection Angles

Usual Stock Sizes	
Depth	Weight
3″	4.1#
4	5.4
5	6.7
6	8.2
7	9.8
8	11.5
9	13.4
10	15.3
12	20.7
15	33.9

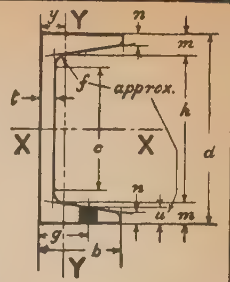
3"

STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

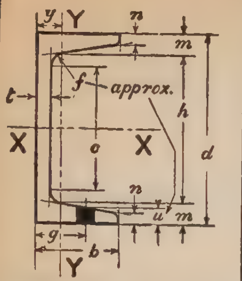
Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



Depth = d"	3	3	3	Live Load Deflection must not exceed 1-360 of the Span. LiveLoad Def. = Total Def. × LiveLoad / Tabular Load
Wt. per foot	**4.1**	5.0	6.0	
Area. sq. in.	1.19	1.46	1.75	
b"	1.41	1.50	1.60	
t	.170	.258	.356	
h	2.246	2.246	2.246	
m	.377	.377	.377	
n	.170	.170	.170	
f	.270	.270	.270	
c	1.789	1.789	1.789	
g	7/8	7/8	7/8	
u	1/4	1/4	1/4	
AXES X-X I	1.6	1.8	2.1	
AXES X-X S	1.07	1.2	1.4	
AXES X-X r	1.17	1.12	1.08	
AXES Y-Y I	0.20	0.25	0.31	
AXES Y-Y S	0.21	0.24	0.27	
AXES Y-Y r	0.41	0.41	0.42	
AXES Y-Y y	0.44	0.44	0.46	
Coef. Str.	12800	14400	16800	Total Deflection in inches for Maximum Load; laterally fixed beam.
Max. Mom." #	19200	21600	25200	
V	6100	9300	12800	
P. feet	1.05	.77	.66	
W	7700	11600	11900	
Q. feet	.83	.62	.71	
w. lbs.	5	5	5	
Rivet dia.	1/2	1/2	1/2	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	4.1 Laterally fixed	4.1 Laterally free	5.0 Laterally fixed	5.0 Laterally free	6.0 Laterally fixed	6.0 Laterally free	Total Deflection
1	12.2	12.2	14.4	14.4	16.8	16.8	
2	6.4	6.3	7.2	7.1	8.4	8.4	.025
3	4.3	3.7	4.8	4.1	5.6	5.0	.056
4	3.2	2 3	3.6	2.6	4.2	3.2	.099
5	2.6	..	2.9	1.8	3.4	2.2	.155
6	2.1	..	2.4	..	2.8	..	.223
7	1.8	..	2.1	..	2.4	..	.304
8	1.6	..	1.8	..	2.1	..	.396
9	1.4	..	1.6	..	1.9	..	.503
10	1.3	..	1.4	..	1.7	..	.620
11	1.2	..	1.3	..	1.5	..	.750
12	1.1	..	1.2	..	1.4	..	.896
13	1.0	..	1.1	..	1.3	..	1.05
14	0.9	..	1.0	..	1.2	..	1.22
15	0.8	..	1.0	..	1.1	..	1.39



STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

4"

Depth = d"	4	4	4
Wt. per foot	5.4	6.25	7.25
Area, sq. in.	1.56	1.82	2.12
b"	1.58	1.65	1.72
t	.180	.247	.320
h	3.174	3.174	3.174
m	.413	.413	.413
n	.180	.180	.180
f	.280	.280	.280
c	2.700	2.700	2.700
g	1"	1"	1"
u	5/16	5/16	5/16
AXES X-X I	3.8	4.1	4.5
AXES X-X S	1.9	2.05	2.25
AXES X-X r	1.56	1.50	1.47
AXES Y-Y I	0.32	0.38	0.44
AXES Y-Y S	0.29	0.32	0.35
AXES Y-Y r	0.45	0.45	0.46
AXES Y-Y y	0.46	0.46	0.46
Coef. Str.	22800	24600	27000
Max. Mom." #	34200	36900	40500
V	8600	11900	15400
P. feet	1.33	1.03	0.88
W	8100	11100	11900
Q. feet	1.41	1.11	1.13
w. lbs.	5	5	5
Rivet dia.	½	½	½

Live Load Deflection must not exceed 1-360 of the Span.
LiveLoad Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	5.4 Laterally fixed	5.4 Laterally free	6.25 Laterally fixed	6.25 Laterally free	7.25 Laterally fixed	7.25 Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	17.2	17.2	23.8	23.8	27.0	27.0	
2	11.4	11.4	12.3	12.3	13.5	13.5	.019
3	7.6	6.7	8.2	7.3	9.0	8.3	.042
4	5.7	4.3	6.2	4.8	6.7	5.4	.074
5	4.6	3.0	4.9	3.4	5.4	3.7	.116
6	3.8	..	4.1	..	4.5	..	.168
7	3.3	..	3.5	..	3.8	..	.228
8	2.9	..	3.1	..	3.4	..	.298
9	2.5	..	2.7	..	3.0	..	.378
10	2.3	..	2.5	..	2.7	..	.465
11	2.1	..	2.2	..	2.5	..	.562
12	1.9	..	2.1	..	2.3	..	.670
13	1.8	..	1.9	..	2.1	..	.787
14	1.6	..	1.8	..	1.9	..	.912
15	1.5	..	1.6	..	1.8	..	1.05

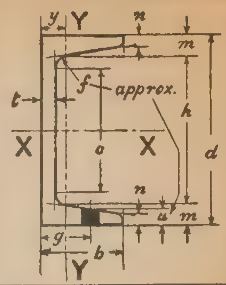
5"

STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

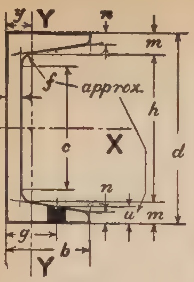
Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



Depth = d"	5	5	5	
Wt. per foot	6.7	9.0	11.5	
Area, sq. in.	1.95	2.63	3.36	
b"	1.75	1.89	2.03	
t	.190	.325	.472	
h	4.100	4.100	4.100	
m	.450	.450	.450	
n	.190	.190	.190	
f	.290	.290	.290	
c	3.609	3.609	3.609	
g	1⅛	1⅛	1⅛	
u	5/16	5/16	5/16	
AXES X-X I	7.4	8.8	10.4	Live Load Deflection must not exceed 1-360 of the Span.
AXES X-X S	2.96	3.52	4.16	LiveLoad Def. = Total Def. × Live Load / Tabular Load
AXES X-X r	1.95	1.83	1.76	
AXES Y-Y I	0.48	0.64	0.82	
AXES Y-Y S	0.38	0.45	0.54	
AXES Y-Y r	0.50	0.49	0.49	
AXES Y-Y y	0.49	0.48	0.51	
Coef. Str.	35500	42200	49900	
Max. Mom." #	53300	63400	74900	
V	11400	19500	28500	
P. feet	1.56	1.08	0.88	
W	8600	11900	11900	
Q. feet	2.07	1.77	2.10	
w. lbs.	6	6	6	
Rivet dia.	½	½	½	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	6.7 Laterally fixed	6.7 Laterally free	9.0 Laterally fixed	9.0 Laterally free	11.5 Laterally fixed	11.5 Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	22.8	22.8	39.0	39.0	49.2	49.2	
2	17.8	17.8	21.1	21.1	24.9	24.9	
3	11.8	10.9	14.0	13.2	16.6	15.6	.033
4	8.9	7.2	10.5	8.8	12.5	10.4	.059
5	7.1	5.0	8.4	6.2	10.0	7.4	.093
6	5.9	..	7.0	4.5	8.3	5.3	.134
7	5.1	..	6.0	..	7.1	..	.182
8	4.4	..	5.3	..	6.2	..	.238
9	3.9	..	4.7	..	5.5	..	.302
10	3.6	..	4.2	..	5.0	..	.372
11	3.2	..	3.8	..	4.5	..	.450
12	3.0	..	3.5	..	4.2	..	.537
13	2.7	..	3.2	..	3.8	..	.630
14	2.5	..	3.0	..	3.6	..	.730
15	2.4	..	2.8	..	3.3	..	.838
16	2.2	..	2.6	..	3.1	..	.955
17	2.1	..	2.5	..	2.9	..	1.08
18	2.0	..	2.3	..	2.8	..	1.20
19	1.9	..	2.2	..	2.6	..	1.34
20	1.8	..	2.1	..	2.5	..	1.49



STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
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V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

6"

Depth = d"		6	6	6	6
Wt. per foot		8.2	10.5	13.0	15.5
Area. sq. in.		2.39	3.07	3.81	4.54
b"		1.92	2.03	2.16	2.28
t		.200	.314	.437	.559
h		5.026	5.026	5.026	5.026
m		.487	487	.487	.487
n		.200	.200	.200	.200
f		.300	.300	.300	.300
c		4.518	4.518	4.518	4.518
g		$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{3}{8}$	$1\frac{3}{8}$
u		$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$
AXES X-X	I	13.0	15.1	17.3	19.5
	S	4.33	5.03	5.77	6.5
	r	2.34	2.22	2.13	2.07
AXES Y-Y	I	0.70	0.87	1.1	1.3
	S	0.50	0.57	0.65	0.73
	r	0.54	0.53	0.53	0.53
	y	0.52	0.50	0.52	0.55
Coef. Str.		52000	60400	69200	78000
Max.Mom." #		78000	90200	103800	117000
V		14400	22600	31500	40200
P. feet		1.81	1.34	1.10	.97
W		9000	11900	11900	11900
Q. feet		2.89	2.54	2.91	3.28
w. lbs.		6	6	6	6
Rivet dia.		$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$

Live Load Deflection must not exceed 1-360 of the Span.

LiveLoad Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	8.2 Laterally fixed	8.2 Laterally free	10.5 Laterally fixed	10.5 Laterally free	13.0 Laterally fixed	13.0 Laterally free	15.5 Laterally fixed	15.5 Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	28.8	28.8	45.2	45.2	63.0	63.0	78.0	78.0	
2	26.0	26.0	30.2	30.2	34.6	34.6	39.0	39.0	
3	17.3	16.4	20.1	19.3	23.1	22.5	26.0	25.7	.028
4	13.0	11.0	15.1	13.1	17.3	15.4	19.5	18.1	.050
5	10.4	7.8	12.1	9.4	13.8	11.0	15.6	12.9	.078
6	8.7	5.7	10.1	6.9	11.5	8.3	13.0	9.6	.112
7	7.4	..	8.6	..	9.9	..	11.1	7.3	.152
8	6.5	..	7.6	..	8.7	..	9.8	..	.198
9	5.8	..	6.7	..	7.7	..	8.7	..	.252
10	5.2	..	6.0	..	6.9	..	7.8	..	.310
11	4.7	..	5.5	..	6.3	..	7.1	..	.375
12	4.3	..	5.0	..	5.8	..	6.5	..	.447
13	4.0	..	4.6	..	5.4	..	6.0	..	.525
14	3.7	..	4.3	..	5.0	..	5.6	..	.608
15	3.5	..	4.0	..	4.6	..	5.2	..	.698
16	3.3	..	3.8	..	4.3	..	4.9	..	.795
17	3.1	..	3.6	..	4.1	..	4.6	..	.898
18	2.9	..	3.4	..	3.8	..	4.3	.	1.01
19	2.7	..	3.2	..	3.6	..	4.1	..	1.12
20	2.6	..	3.0	..	3.5	..	3.9	..	1.24
21	2.5	..	2.9	..	3.3	..	3.7	..	1.37
22	2.4	..	2.7	..	3.1	..	3.5	..	1.51
23	2.3	..	2.6	..	3.0	..	3.4	..	1.64
24	2.2	..	2.5	..	2.9	..	3.3	..	1.79
25	2.1	..	2.4	.	2.8	..	3.1	..	1.94

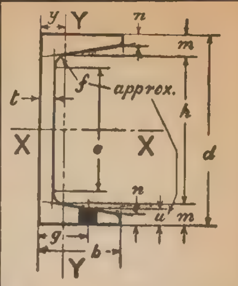
7"

STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

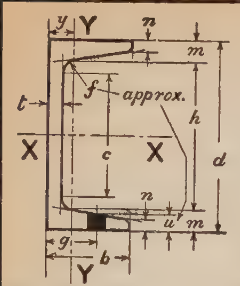


Depth = d"	7	7	7	7	7
Wt. per foot	9.8	12.25	14.75	17.25	19.75
Area, sq. in.	2.85	3.58	4.32	5.05	5.79
b"	2.09	2.19	2.30	2.40	2.51
t	.210	.314	.419	.524	.629
h	5.954	5.954	5.954	5.954	5.954
m	.523	.523	.523	.523	.523
n	.210	.210	.210	.210	.210
f	.310	.310	.310	.310	.310
c	5.429	5.429	5.429	5.429	5.429
g	1¼	1¼	1¼	1½	1½
u	⅜	⅜	7/16	7/16	7/16
AXES X-X I	21.1	24.1	27.1	30.1	33.1
AXES X-X S	6.03	6.88	7.74	8.60	9.46
AXES X-X r	2.72	2.59	2.51	2.44	2.39
AXES Y-Y I	0.98	1.2	1.4	1.6	1.8
AXES Y-Y S	0.63	0.71	0.79	0.86	0.96
AXES Y-Y r	0.59	0.58	0.57	0.56	0.56
AXES Y-Y y	0.55	0.53	0.53	0.55	0.58
Coef. Str.	72300	82600	92900	103200	113500
Max. Mom." #	108500	123900	139400	154800	170200
V	17600	26500	35200	44000	52800
P. feet	2.05	1.56	1.32	1.17	1.07
W	9500	11900	11900	11900	11900
Q. feet	3.81	3.47	3.90	4.34	4.77
w. lbs.	6	6	6	6	6
Rivet dia.	⅝	⅝	⅝	⅝	⅝

Live Load Deflection must not exceed 1-360 of the Span.
LiveLoad Def. = Total Def. × LiveLoad / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	9.8 Laterally fixed	9.8 Laterally free	12.25 Laterally fixed	12.25 Laterally free	14.75 Laterally fixed	14.75 Laterally free	17.25 Laterally fixed	17.25 Laterally free	19.75 Laterally fixed	19.75 Laterally free	Total Deflection in inches for Maximum Load, laterally fixed beam.
1	35.2	35.2	52.8	52.8	70.4	70.4	88.0	88.0			
2	35.2	35.2	41.3	41.3	46.4	46.4	51.6	51.6	56.8	56.8	
3	24.1	23.3	27.5	26.9	31.0	30.7	34.4	34.4	37.8	37.8	.024
4	18.1	15.9	20.7	18.5	23.2	21.2	25.8	23.9	28.4	26.7	.043
5	14.5	11.2	16.5	13.4	18.6	15.4	20.6	17.4	22.7	19.6	.067
6	12.1	8.5	13.8	10.0	15.5	11.1	17.2	13.3	18.9	14.9	.096
7	10.3	6.4	11.8	7.6	13.3	8.9	14.7	10.1	16.2	11.6	.130
8	9.0	..	10.3	..	11.6	..	12.9	8.0	14.2	9.1	.170
9	8.0	..	9.2	..	10.3	..	11.5	..	12.6	..	.216
10	7.2	..	8.3	..	9.3	..	10.3	..	11.4	..	.266
11	6.6	..	7.5	..	8.4	..	9.4	..	10.3	..	.321
12	6.0	..	6.9	..	7.7	..	8.6	..	9.5	..	.383
13	5.5	..	6.4	..	7.1	..	7.9	..	8.7	..	.450
14	5.1	..	5.9	..	6.6	..	7.4	..	8.1	..	.521
15	4.8	..	5.5	..	6.2	..	6.9	..	7.6	..	.599
16	4.5	..	5.2	..	5.8	..	6.5	..	7.1	..	.681
17	4.3	..	4.9	..	5.5	..	6.1	..	6.7	..	.770
18	4.0	..	4.6	..	5.2	..	5.7	..	6.3	..	.861
19	3.8	..	4.3	..	4.9	..	5.4	..	6.0	..	.960
20	3.6	..	4.1	..	4.6	..	5.2	..	5.7	..	1.06
21	3.4	..	3.9	..	4.4	..	4.9	..	5.4	..	1.17
22	3.3	..	3.8	..	4.2	..	4.7	..	5.2	..	1.29
23	3.1	..	3.6	..	4.0	..	4.4	..	4.9	..	1.41
24	3.0	..	3.4	..	3.9	..	4.3	..	4.7	..	1.53
25	2.9	..	3.3	..	3.7	..	4.1	..	4.5	..	1.66



STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

8"

Depth = d"	8	8	8	8	8	
Wt. per foot	**11.50**	13.75	16.25	18.75	21.25	
Area. sq. in.	3.36	4.02	4.76	5.49	6.23	
b"	2.26	2.34	2.44	2.53	2.62	
t	.220	.303	.395	.487	.579	
h	6.880	6.880	6.880	6.880	6.880	
m	.560	.560	.560	.560	.560	
n	.220	.220	.220	.220	.220	
f	.320	.320	.320	.320	.320	
c	6.338	6.338	6.338	6.338	6.338	
g	1⅜	1⅜	1½	1½	1½	
u	⅜	⅜	7/16	7/16	7/16	
AXES X-X I	32.3	35.8	39.8	43.7	47.6	Live Load Deflection must not exceed 1-360 of the Span. LiveLoad Def. = Total Def. × LiveLoad / Tabular Load
AXES X-X S	8.08	8.95	9.95	10.92	11.9	
AXES X-X r	3.10	2.99	2.89	2.82	2.77	
AXES Y-Y I	1.3	1.5	1.8	2.0	2.2	
AXES Y-Y S	.79	.86	.94	1.0	1.1	
AXES Y-Y r	.63	.62	.61	.60	.60	
AXES Y-Y y	.58	.56	.56	.57	.59	
Coef. Str.	96900	107400	119400	131100	142800	
Max. Mom." #	145400	161100	179100	196700	214200	
V	21100	29100	37900	46800	55600	
P. feet	2.30	1.80	1.58	1.40	1.28	
W	19800	23800	23800	23800	23800	
Q. feet	2.45	2.26	2.51	2.75	3.00	
w. lbs.	13	13	13	13	13	
Rivet dia.	¾	¾	¾	¾	¾	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	11.50 Laterally fixed	11.50 Laterally free	13.75 Laterally fixed	13.75 Laterally free	16.25 Laterally fixed	16.25 Laterally free	18.75 Laterally fixed	18.75 Laterally free	21.25 Laterally fixed	21.25 Laterally free	Total Deflection in inches for Maximum Load, laterally fixed beam.
1	42.2	42.2	58.2	58.2	75.8	75.8	93.6	93.6			
2	42.2	42.2	53.7	53.7	59.7	59.7	65.6	65.6	71.4	71.4	
3	32.3	31.9	35.8	35.6	39.8	39.8	43.7	43.7	47.6	47.6	.021
4	24.2	22.0	26.9	24.7	29.8	27.7	32.8	30.9	35.7	34.0	.037
5	19.4	15.9	21.5	18.0	23.9	20.4	26.3	22.8	28.6	25.2	.058
6	16.1	12.0	17.9	13.5	19.9	15.4	21.9	17.3	23.8	19.2	.084
7	13.8	9.0	15.3	10.3	17.1	12.0	18.7	13.4	20.4	15.0	.114
8	12.1	..	13.4	..	14.9	9.3	16.4	10.6	17.9	11.9	.149
9	10.8	..	11.9	..	13.3	..	14.5	..	15.9	..	.189
10	9.7	..	10.7	..	11.9	..	13.1	..	14.3	..	.233
11	8.8	..	9.8	..	10.8	..	11.9	..	13.0	..	.281
12	8.1	..	8.9	..	9.9	..	10.9	..	11.9	..	.335
13	7.5	..	8.3	..	9.1	..	10.1	..	11.0	..	.394
14	6.9	..	7.7	..	8.5	..	9.3	..	10.2	..	.456
15	6.5	..	7.2	..	7.9	..	8.7	..	9.5	..	.524
16	6.1	..	6.8	..	7.4	..	8.2	..	8.9	..	.596
17	5.7	..	6.4	..	7.0	..	7.7	..	8.4	..	.674
18	5.4	..	6.0	..	6.6	..	7.3	..	7.9	..	.754
19	5.1	..	5.7	..	6.3	..	6.9	..	7.5	..	.840
20	4.8	..	5.4	..	6.0	..	6.6	..	7.1	..	.931
21	4.6	..	5.1	..	5.7	..	6.2	..	6.8	..	1.03
22	4.4	..	4.9	..	5.4	..	6.0	..	6.5	..	1.13
23	4.2	..	4.7	..	5.2	..	5.7	..	6.2	..	1.23
24	4.0	..	4.5	..	5.0	..	5.5	..	6.0	..	1.34
25	3.9	..	4.3	..	4.8	..	5.2	..	5.7	..	1.46

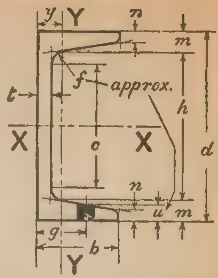
9"

STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

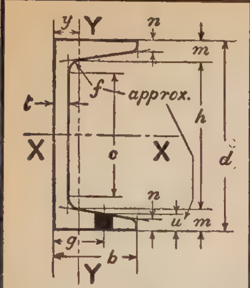
Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



Depth = d"	9	9	9	9	Live Load Deflection must not exceed 1-360 of the Span. LiveLoad Def. = (Total Def. × Live Load) / Tabular Load
Wt. per foot	**13.4**	15.0	20.0	25.0	
Area, sq. in.	3.89	4.39	5.86	7.33	
b"	2.43	2.49	2.65	2.81	
t	.230	.285	.448	.612	
h	7.806	7.806	7.806	7.806	
m	.597	.597	.597	.597	
n	.230	.230	.230	.230	
f	.330	.330	.330	.330	
c	7.247	7.247	7.247	7.247	
g	1⅜	1⅜	1½	1½	
u	7/16	7/16	½	½	
AXES X-X I	47.3	50.7	60.6	70.5	
AXES X-X S	10.51	11.27	13.47	15.66	
AXES X-X r	3.49	3.40	3.22	3.10	
AXES Y-Y I	1.8	1.9	2.4	3.0	
AXES Y-Y S	0.97	1.0	1.2	1.4	
AXES Y-Y r	.67	.67	.65	.64	
AXES Y-Y y	.61	.59	.59	.61	
Coef. Str.	126100	135200	161600	188000	Total Deflection in inches for Maximum Load; laterally fixed beam
Max. Mom." #	189200	202800	242400	282000	
V	24800	30800	48500	66100	
P. feet	2.54	2.19	1.67	1.42	
W	20700	23800	23800	23800	
Q. feet	3.05	2.84	3.39	3.95	
w. lbs.	13	13	13	13	
Rivet dia.	¾	¾	¾	¾	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	13.4 Laterally fixed	13.4 Laterally free	15.0 Laterally fixed	15.0 Laterally free	20.0 Laterally fixed	20.0 Laterally free	25.0 Laterally fixed	25.0 Laterally free	Total Deflection
1	49.6	49.6	61.6	61.6	97.0	97.0	132	132	
2	49.6	49.6	61.6	61.6	80.8	80.8	94.0	94.0	
3	42.0	42.0	45.1	45.1	53.9	53.9	62.7	62.7	.019
4	31.5	29.3	33.8	31.7	40.4	38.6	47.0	45.5	.033
5	25.2	21.5	27.0	23.2	32.3	28.6	37.6	34.1	.052
6	21.0	16.2	22.5	17.6	26.9	21.8	31.3	26.2	.074
7	18.0	12.5	19.4	13.7	23.1	17.1	26.9	20.6	.101
8	15.8	9.9	16.9	10.7	20.2	13.6	23.5	16.5	.132
9	14.0	..	15.0	..	18.0	..	21.0	13.4	.168
10	12.6	..	13.5	..	16.2	..	18.8	..	.207
11	11.5	..	12.3	..	14.7	..	17.1	..	.250
12	10.5	..	11.3	..	13.5	..	15.7	..	.298
13	9.7	..	10.4	..	12.4	..	14.5	..	.350
14	9.0	..	9.7	..	11.5	..	13.4	..	.406
15	8.4	..	9.0	..	10.8	..	12.5	..	.466
16	7.9	..	8.4	..	10.2	..	11.8	..	.530
17	7.4	..	8.0	..	9.5	..	11.1	..	.599
18	7.0	..	7.5	..	9.0	..	10.4	..	.670
19	6.6	..	7.1	..	8.5	..	9.9	..	.747
20	6.3	..	6.8	..	8.1	..	9.4	..	.828
21	6.0	..	6.4	..	7.7	..	9.0	..	.912
22	5.7	..	6.1	..	7.3	..	8.5	..	1.00
23	5.5	..	5.9	..	7.0	..	8.2	..	1.10
24	5.3	..	5.6	..	6.7	..	7.8	..	1.19
25	5.0	..	5.4	..	6.5	..	7.5	..	1.29



STANDARD CHANNELS

DIMENSIONS*—FUNCTIONS—ALLOWABLE TOTAL LOADS

10"

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

Depth = d"	10	10	10	10	10	Live Load Deflection must not exceed 1-360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot	15.3	20.0	25.0	30.0	35.0	
Area. sq. in.	4.47	5.86	7.33	8.80	10.27	
b"	2.60	2.74	2.89	3.03	3.18	
t	.240	.379	.526	.673	.820	
h	8.734	8.734	8.734	8.734	8.734	
m	.633	.633	.633	.633	.633	
n	.240	.240	.240	.240	.240	
f	.340	.340	.340	.340	.340	
c	8.158	8.158	8.158	8.158	8.158	
g	1½	1½	1¾	1¾	1¾	
u	7/16	7/16	½	½	½	
AXES X-X I	66.9	78.5	90.7	103.0	115.2	
AXES X-X S	13.38	15.7	18.14	20.6	23.04	
AXES X-X r	3.87	3.66	3.52	3.42	3.34	
AXES Y-Y I	2.3	2.8	3.4	4.0	4.6	
AXES Y-Y S	1.2	1.3	1.5	1.7	1.9	
AXES Y-Y r	.72	.70	.68	.67	.67	
AXES Y-Y y	.64	.61	.62	.65	.69	
Coef. Str.	160600	188400	217700	247200	276500	Total Deflection in inches for Maximum Load; laterally fixed beam.
Max. Mom." *	240900	282600	326500	370800	414700	
V	28800	45500	63100	80800	98400	
P. feet	2.79	2.07	1.73	1.53	1.41	
W	21600	23800	23800	23800	23800	
Q. feet	3.72	3.96	4.57	5.19	5.81	
w. lbs.	13	13	13	13	13	
Rivet dia.	¾	¾	¾	¾	¾	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	15.3 Laterally fixed	15.3 Laterally free	20.0 Laterally fixed	20.0 Laterally free	25.0 Laterally fixed	25.0 Laterally free	30.0 Laterally fixed	30.0 Laterally free	35.0 Laterally fixed	35.0 Laterally free	Total Deflection
1	58	58	91	91	126	126	162	162	197	197	
2	58	58	91	91	109	109	124	124	138	138	
3	54	54	63	63	73	73	82	82	92	92	.017
4	40	38	47	45	54	53	62	61	69	69	.030
5	32	28	38	34	44	40	49	46	55	52	.047
6	27	22	31	26	36	31	41	36	46	41	.067
7	23	17	27	20	31	24	35	28	40	33	.091
8	20	14	24	16	27	20	31	23	35	26	.119
9	18	...	21	13	24	16	28	19	31	22	.151
10	16	...	19	...	22	...	25	15	28	18	.186
11	15	...	17	...	20	...	23	...	25	...	.225
12	13	...	16	...	18	...	21	...	23	...	.268
13	12	...	15	...	17	...	19	...	21	...	.315
14	12	...	14	...	16	...	18	...	20	...	.365
15	11	...	13	...	15	...	17	...	18	...	.419
16	10	...	12	...	14	...	16	...	17	...	.477
17	9	...	11	...	13	...	15	...	16	...	.539
18	9	...	11	...	12	...	14	...	15	...	.603
19	8	...	10	...	12	...	13	...	15	...	.672
20	8	...	9	...	11	...	12	...	14	...	.745
21	8	...	9	...	10	...	12	...	13	...	.821
22	7	...	8	...	10	...	11	...	13	...	.901
23	7	...	8	...	10	...	11	...	12	...	.986
24	7	...	8	...	9	...	10	...	12	...	1.07
25	6	...	8	...	9	...	10	...	11	...	1.16

12" [

STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
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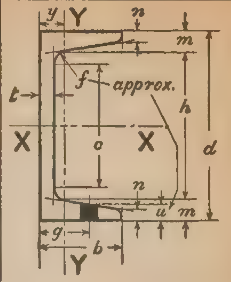
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



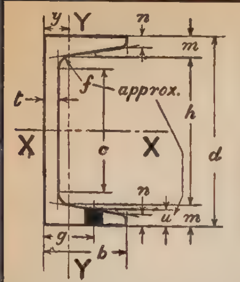
Depth = d"	12	12	12	12	12
Wt. per foot	**20.7**	25.0	30.0	35.0	40.0
Area. sq. in.	6.03	7.32	8.79	10.26	11.73
b"	2.94	3.05	3.17	3.29	3.42
t	.280	.387	.510	.632	.755
h	10.554	10.554	10.554	10.554	10.554
m	.723	.723	.723	.723	.723
n	.280	.280	.280	.280	.280
f	.380	.380	.380	.380	.380
c	9.910	9.910	9.910	9.910	9.910
g	1¾	1¾	1¾	2	2
u	½	½	½	⅝	⅝
AXES X-X I	128.1	143.5	161.2	178.8	196.5
AXES X-X S	21.35	23.92	26.87	29.8	32.75
AXES X-X r	4.61	4.43	4.28	4.18	4.09
AXES Y-Y I	3.9	4.5	5.2	5.9	6.6
AXES Y-Y S	1.7	1.9	2.1	2.3	2.5
AXES Y-Y r	.81	.79	.77	.76	.75
AXES Y-Y y	.70	.68	.68	.69	.72
Coef. Str.	256200	287000	322400	357600	393000
Max. Mom." *	384300	430500	483600	536400	589500
V	40300	55700	73400	91000	108700
P. feet	3.18	2.58	2.20	1.96	1.81
W	23860	23860	23860	23860	23860
Q. feet	5.37	6.01	6.76	7.49	8.24
w. lbs.	13	13	13	13	13
Rivet dia.	⅞	⅞	⅞	⅞	⅞

Live Load Deflection must not exceed 1-360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	81	81	111	111	147	147	182	182	217	217	
2	81	81	111	111	147	147	179	179	197	197	
3	81	81	96	96	108	108	119	119	131	131	.014
4	64	63	72	71	81	80	89	89	98	98	.025
5	51	47	57	53	65	61	72	68	79	76	.039
6	43	37	48	42	54	47	60	53	66	60	.056
7	37	29	41	33	46	38	51	43	56	48	.076
8	32	23	36	27	40	31	45	35	49	39	.099
9	28	19	32	22	36	25	40	29	44	32	.126
10	26	...	29	18	32	21	36	24	39	27	.155
11	23	...	26	...	29	...	33	...	36	23	.188
12	21	...	24	...	27	...	30	...	33	...	.223
13	20	...	22	...	25	...	28	...	30	...	.263
14	18	...	21	...	23	...	26	...	28	...	.304
15	17	...	19	...	22	...	24	...	26	...	.341
16	16	...	18	...	20	...	22	...	25	...	.398
17	15	...	17	...	19	...	21	...	23	...	.449
18	14	...	16	...	18	...	20	...	22	...	.503
19	13	...	15	...	17	...	19	...	21	...	.560
20	13	...	14	...	16	...	18	...	20	...	.621
21	12	...	14	...	15	...	17	...	19	...	.684
22	12	...	13	...	15	...	16	...	18	...	.751
23	11	...	13	...	14	...	16	...	17	...	.822
24	11	...	12	...	13	...	15	...	16	...	.894
25	10	...	12	...	13	...	14	...	16	...	.970
26	10	...	11	...	12	...	14	...	15	...	1.050



STANDARD CHANNELS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets
y is Distance in inches between Center of Gravity and back of Channel

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

15"

Depth = d"	15	15	15	15	15	15
Wt. per foot...	**33.9**	35.0	40.0	45.0	50.0	55.0
Area. sq. in...	9.90	10.23	11.70	13.17	14.64	16.11
b"......	3.40	3.42	3.52	3.62	3.72	3.81
t........	.400	.422	.520	.618	.716	.814
h........	13.200	13.200	13.200	13.200	13.200	13.200
m........	.900	.900	.900	.900	.900	.900
n........	.400	.400	.400	.400	.400	.400
f........	.50	.50	.50	.50	.50	.50
c........	12.353	12.353	12.353	12.353	12.353	12.353
g........	2	2	2	2	2½	2½
u........	⅝	⅝	⅝	⅝	11/16	11/16
AXES X-X I:...	312.6	318.7	346.3	373.9	401.4	429.0
AXES X-X S....	41.68	42.49	46.17	49.85	53.52	57.2
AXES X-X r....	5.62	5.58	5.44	5.33	5.24	5.16
AXES Y-Y I....	8.2	8.4	9.3	10.3	11.2	12.1
AXES Y-Y S....	3.2	3.2	3.4	3.6	3.8	4.1
AXES Y-Y r....	.91	.91	.89	.88	.87	.87
AXES Y-Y y....	.79	.79	.78	.79	.80	.82
Coef. Str.....	500200	509900	554100	598200	642200	686400
Max.Mom." #	750300	764900	831100	897300	963400	1029600
V........	72000	76000	93600	111200	128900	146500
P. feet...	3.47	3.35	2.96	2.69	2.49	2.34
W.......	36000	38000	46800	47700	47700	47700
Q. feet...	6.95	6.71	5.92	6.27	6.73	7.19
w. lbs....	19	19	19	19	19	19
Rivet dia.....	⅞	⅞	⅞	⅞	⅞	⅞

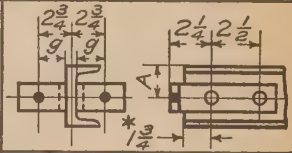
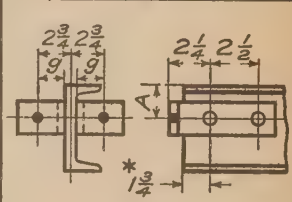
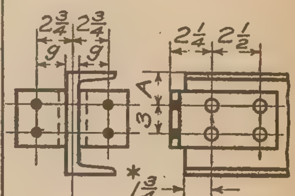
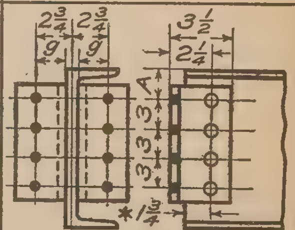
Live Load Deflection must not exceed 1-360 of the Span. LiveLoadDef. = TotalDef. × LiveLoad / Tabular Load

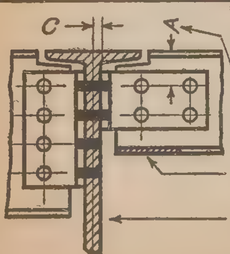
Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	free	Laterally fixed	free	Laterally fixed	free	Laterally fixed	free	Laterally fixed	free	Laterally fixed	free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	144	144	152	152	187	187	222	222	258	258	293	293	
2	144	144	152	152	187	187	222	222	258	258	293	293	
3	144	144	152	152	187	185	199	199	214	214	229	229	.011
4	125	125	128	127	139	138	150	150	161	161	172	172	.020
5	100	96	102	98	111	108	120	117	128	126	137	136	.031
6	83	76	85	77	92	85	100	93	107	100	114	108	.045
7	71	61	73	62	79	69	86	75	92	81	98	88	.061
8	63	50	64	51	69	56	75	62	80	67	86	72	.079
9	56	41	57	42	62	47	67	51	72	56	76	61	.101
10	50	34	51	35	55	39	60	43	64	47	69	51	.124
11	45	29	46	30	50	33	54	36	58	40	62	43	.150
12	42	..	43	..	46	..	50	30	54	34	57	37	.179
13	39	..	39	..	43	..	46	..	49	..	53	..	.210
14	36	..	36	..	40	..	43	..	46	..	49	..	.243
15	33	..	34	..	37	..	40	..	43	..	46	..	.279
16	31	..	32	..	35	..	37	..	40	..	43	..	.318
17	29	..	30	..	33	..	35	..	38	..	41	..	.359
18	28	..	28	..	31	..	33	..	36	..	39	..	.402
19	26	..	27	..	29	..	32	..	34	..	36	..	.448
20	25	..	26	..	28	..	30	..	32	..	34	..	.497
21	24	..	24	..	26	..	29	..	31	..	33	..	.547
22	23	..	23	..	25	..	27	..	29	..	31	..	.601
23	22	..	22	..	24	..	26	..	28	..	30	..	.651
24	21	..	21	..	23	..	25	..	27	..	29	..	.715
25	20	..	20	..	22	..	24	..	26	..	28	..	.776
26	19	..	20	..	21	..	23	..	25	..	26	..	.839
27	19	..	19	..	21	..	22	..	24	..	25	..	.909
28	18	..	18	..	20	..	21	..	23	..	25	..	.973
29	17	..	18	..	19	..	21	..	22	..	24	..	1.040
30	17	..	17	..	19	..	20	..	21	..	23	..	1.120
31	16	..	16	..	18	..	19	..	21	..	22	..	1.190
32	16	..	16	..	17	..	19	..	20	..	22	..	1.270

CONNECTION ANGLES FOR AMERICAN STANDARD CHANNELS

DIMENSIONS, WEIGHTS, AND WORKING LOADS. **3/4" POWER DRIVEN RIVETS.**

Channel		Connection Value			Framing Distance	Connection Angles				Connection Details.
			Outstanding Single Shear							
Depth	Weight per foot	Web	Power Driven Rivets	Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	
3"	4.1	7650	11930	8840	1/4	IC. 5.11	2 11/16	6" × 4" × 3/8" 0' — 2" Long	5 lbs.	
	5.0	11610	"	"	5/16	IC. 5.10	2 5/8			
	6.0	16020	"	"	7/16	IC. 5. 9	2 9/16			
4"	5.4	8100	11930	8840	1/4	IC. 5.11	2 11/16			
	6.25	11120	"	"	5/16	IC. 5.10	2 5/8			
	7.25	14400	"	"	3/8	IC. 5. 9	2 9/16			
5"	6.7	8550	11930	8840	1/4	IC. 6.10	2 5/8	6" × 4" × 3/8" 0' — 2½" Long	6 lbs.	
	9.0	14630	"	"	3/8	IC. 6. 9	2 9/16			
	11.5	21240	"	"	9/16	IC. 6. 8	2 1/2			
6"	8.2	9000	11930	8840	1/4	IC. 6.10	2 5/8			
	10.5	14130	"	"	3/8	IC. 6. 9	2 9/16			
	13.0	19670	"	"	1/2	IC. 6. 9	2 9/16			
	15.5	23860	"	"	5/8	IC. 6. 8	2 1/2			
7"	9.8	9450	11930	8840	1/4	IC. 6.10	2 5/8			
	12.25	14130	"	"	3/8	IC. 6. 9	2 9/16			
	14.75	18860	"	"	1/2	IC. 6. 9	2 9/16			
	17.25	23580	"	"	9/16	IC. 6. 8	2 1/2			
	19.75	23860	"	"	11/16	IC. 6. 7	2 7/16			
8"	11.5	19800	23860	17670	5/16	IC.13.10	2 5/8	6" × 4" × 3/8" 0' — 5½" Long	13 lbs.	
	13.75	27270	"	"	3/8	IC.13.10	2 5/8			
	16.25	35550	"	"	7/16	IC.13. 9	2 9/16			
	18.75	43830	"	"	9/16	IC.13. 8	2 1/2			
	21.25	47720	"	"	5/8	IC.13. 7	2 7/16			
9"	13.4	20700	23860	17670	5/16	IC.13.10	2 5/8			
	15.0	25650	"	"	3/8	IC.13.10	2 5/8			
	20.0	40320	"	"	1/2	IC.13. 8	2 1/2			
	25.0	47720	"	"	11/16	IC.13. 7	2 7/16			
10"	15.3	21600	23860	17670	5/16	IC.13.10	2 5/8			
	20.0	34100	"	"	7/16	IC.13. 9	2 9/16			
	25.0	47340	"	"	9/16	IC.13. 8	2 1/2			
	30.0	47720	"	"	3/4	IC.13. 7	2 7/16			
	35.0	"	"	"	7/8	IC.13. 6	2 3/8			
12"	20.7	25200	23860	17670	5/16	IC.13.10	2 5/8			
	25.0	34830	"	"	7/16	IC.13. 9	2 9/16			
	30.0	45900	"	"	9/16	IC.13. 8	2 1/2			
	35.0	47720	"	"	11/16	IC.13. 7	2 7/16			
	40.0	"	"	"	13/16	IC.13. 6	2 3/8			
15"	33.9	36000	47720	35340	7/16	IC.19. 9	2 9/16	4" × 3½" × 3/8" 0' — 11½" Long	19 lbs.	
	35.0	37980	"	"	1/2	IC.19. 9	2 9/16			
	40.0	46800	"	"	9/16	IC.19. 8	2 1/2			
	45.0	47720	47720	35340	11/16	IC.19. 7	2 7/16			
	50.0	"	"	"	3/4	IC.19. 6	2 3/8			
	55.0	"	"	"	7/8	IC.19. 5	2 5/16			



*Layer-out starts with this dimension at left end of beam. With beams ordered one inch short, as usual in standard shop practice, this leaves sufficient end distance or clearance at right end, in case of full allowable 3/8" underrun or 3/8" overrun in beam lengths.

When A = 3" all beams and channels from 24" 100 lb. to 5" inclusive, can be framed opposite with tops flush.

When A = 3¼" all beams and channels from 24" 120 lb. to 6" inclusive, excepting 8", can be framed opposite with tops flush.

Flange must be cut away as shown, for field riveting, on all beams (excepting 5" and 8") framing opposite a larger beam which has a different size standard connection.

Minimum Web required to develop Single Shearing Value is .33"
Minimum Web required to develop Double Shearing Value is .53"

LOADS BY A. I. S. C. SPECIFICATION

Part IV

Section 4

American Standard Beams

Dimensions

Technical Functions

Allowable Total Loads
by
A. I. S. C. Specification

Allowable End Reactions

Standard Connection Angles

Usual Stock Sizes	
Depth	Weight
3″	5.7#
4	7.7
5	10.0
6	12.5
7	15.3
8	18.4
9	21.8
10	25.4
12	31.8
15	42.9
18	54.7
20	65.4
24	79.9

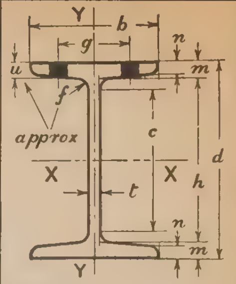
3" I

STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

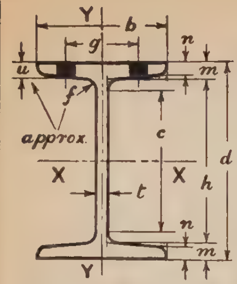


Depth = d"	3	3	3
Wt. per foot	5.7	6.5	7.5
Area, sq. in.	1.64	1.88	2.17
b"	2.33	2.41	2.51
t	.170	.251	.349
h	2.300	2.300	2.300
m	.350	.350	.350
n	.170	.170	.170
f	.270	.270	.270
c	1.843	1.843	1.843
g	1½	1½	1½
u	5/16	5/16	5/16
AXES X-X I	2.5	2.7	2.9
AXES X-X S	1.67	1.80	1.93
AXES X-X r	1.23	1.19	1.15
AXES Y-Y I	0.46	0.51	0.59
AXES Y-Y S	0.40	0.43	0.47
AXES Y-Y r	0.53	0.52	0.52
Coef. Str.	20000	21600	23200
Max. Mom." #	30000	32400	34800
V	6100	9000	12600
P. feet	1.64	1.20	0.92
R	6100	9000	12600
W	7650	11300	11900
Q. feet	1.31	0.96	0.97
w. lbs.	5	5	5
Rivet dia.	⅜	⅜	⅜

Live Load Deflection must not exceed 1-360 of the Span.
Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	12.2	12.2	18.0	18.0	23.2	23.2	
2	10.0	10.0	10.8	10.8	11.6	11.6	.025
3	6.7	6.6	7.2	7.2	7.7	7.7	.056
4	5.0	4.6	5.4	5.0	5.8	5.5	.099
5	4.0	3.3	4.3	3.6	4.6	4.0	.155
6	3.3	2.5	3.6	2.8	3.9	3.1	.223
7	2.9	1.9	3.1	2.1	3.3	2.3	.304
8	2.5	..	2.7	1.7	2.9	1.9	.396
9	2.2	...	2.4	..	2.6	..	.503
10	2.0	...	2.2	..	2.3	..	.620
11	1.8	...	2.0	..	2.1	..	.750
12	1.7	...	1.8	..	1.9	..	.896
13	1.5	...	1.7	..	1.8	..	1.05
14	1.4	...	1.5	..	1.7	..	1.22
15	1.3	...	1.4	..	1.5	..	1.39



STANDARD BEAMS

4" I

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

Depth = d"		4	4	4	4
Wt. per foot		7.7	8.5	9.5	10.5
Area, sq. in.		2.21	2.46	2.76	3.05
b"		2.66	2.72	2.80	2.87
t		.190	.253	.326	.400
h		3.208	3.208	3.208	3.208
m		.396	.396	.396	.396
n		.190	.190	.190	.190
f		.29	.29	.29	.29
c		2.717	2.717	2.717	2.717
g		1½	1½	1½	1½
u		5/16	5/16	5/16	5/16
AXES X-X	I	6.0	6.3	6.7	7.1
AXES X-X	S	3.0	3.15	3.35	3.55
AXES X-X	r	1.64	1.60	1.56	1.52
AXES Y-Y	I	0.77	0.83	0.91	1.0
AXES Y-Y	S	0.58	0.61	0.65	0.70
AXES Y-Y	r	0.59	0.58	0.58	0.57
Coef. Str.		36000	37800	40200	42600
Max. Mom." #		54000	56700	60300	63900
V		9100	12100	15600	19200
P. feet		1.98	1.56	1.29	1.11
R		9100	12100	15600	19200
W		8550	11400	11900	11900
Q. feet		2.11	1.66	1.69	1.79
w. lbs.		5	5	5	5
Rivet dia.		½	½	½	½

Live Load Deflection must not exceed 1-360 of the Span.
Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	18.2	18.2	24.2	24.2	31.2	31.2	38.4	38.4	
2	18.0	18.0	18.9	18.9	20.1	20.1	21.3	21.3	.019
3	12.0	12.0	12.6	12.6	13.4	13.4	14.2	14.2	.042
4	9.0	8.6	9.5	9.1	10.1	10.0	10.7	10.4	.074
5	7.2	6.4	7.6	6.8	8.0	7.2	8.5	7.7	.116
6	6.0	4.9	6.3	5.2	6.7	5.6	7.1	6.0	.168
7	5.1	3.8	5.4	4.1	5.7	4.4	6.1	4.7	.228
8	4.5	3.0	4.7	3.2	5.0	3.5	5.3	3.8	.298
9	4.0	...	4.2	2.6	4.5	2.9	4.7	3.1	.378
10	3.6	...	3.8	...	4.0	...	4.3	...	.465
11	3.3	...	3.4	...	3.7	...	3.9	...	.562
12	3.0	...	3.1	...	3.4	...	3.6	...	.670
13	2.8	...	2.9	...	3.1	...	3.3	...	.787
14	2.6	...	2.7	...	2.9	...	3.0	...	.912
15	2.4	...	2.5	...	2.7	...	2.8	...	1.05

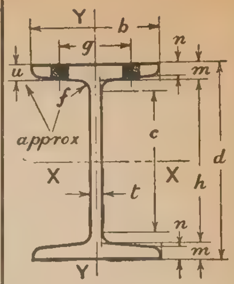
5" I

STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



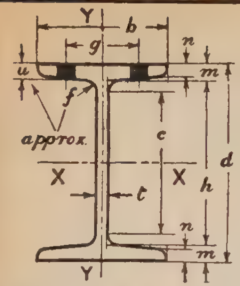
Depth = d"		5	5	5
Wt. per foot		10.0	12.25	14.75
Area, sq. in.		2.87	3.56	4.29
b"		3.00	3.14	3.28
t		.210	.347	.494
h		4.114	4.114	4.114
m		.443	.443	.443
n		.210	.210	.210
f		.31	.31	.31
c		3.589	3.589	3.589
g		1¾	1¾	1¾
u		⅜	⅜	⅜
AXES X-X	I	12.1	13.5	15.0
	S	4.84	5.40	6.00
	r	2.05	1.95	1.87
AXES Y-Y	I	1.2	1.4	1.7
	S	0.82	0.91	1.0
	r	0.65	0.63	0.63
Coef. Str.		58100	64800	72000
Max.Mom." #		87120	97200	108000
V		12600	20800	29600
P. feet		2.30	1.56	1.22
R		12600	20800	29600
W		9450	11900	11900
Q. feet		3.07	2.73	3.03
w. lbs.		6	6	6
Rivet dia.		½	½	½

Live Load Deflection must not exceed 1-360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
1	25.2	25.2	41.6	41.6	59.2	59.2	
2	25.2	25.2	32.4	32.4	36 0	36.0	
3	19.4	19.4	21.6	21.6	24.0	24.0	.033
4	14.5	14.3	16.2	16.1	18.0	18.0	.059
5	11.6	10.7	13.0	12.2	14.4	13.7	.093
6	9.7	8.4	10.8	9.5	12.0	10.8	.134
7	8.3	6.6	9.3	7.6	10.3	8.6	.182
8	7.3	5.4	8.1	6.1	9.0	7.0	.238
9	6.5	4.4	7.2	5.0	8.0	5.8	.302
10	5.8	...	6.5	4.2	7.2	4.8	.372
11	5.3	...	5.9	...	6.5	...	.450
12	4 8	...	5.4	...	6.0	...	.537
13	4.5	...	5.0	...	5.5	...	.630
14	4.2	...	4.6	...	5.1	...	.730
15	3.9	...	4.3	...	4.8	...	.838
16	3.6	...	4.1	...	4.5	...	.955
17	3.4	...	3.8	...	4.2	...	1.08
18	3.2	...	3.6	...	4.0	...	1.20
19	3.1	...	3.4	...	3.8	...	1.34
20	2.9	...	3.2	...	3.6	...	1.49



STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

6" I

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

Depth = d"	6	6	6
Wt. per foot	12.5	14.75	17.25
Area, sq. in.	3.61	4.29	5.02
b"	3.33	3.44	3.57
t	.230	.343	.465
h	5.024	5.024	5.024
m	.488	.488	.488
n	.230	.230	.230
f	.33	.33	.33
c	4.465	4.465	4.465
g	2	2	2
u	⅜	⅜	⅜
AXES X-X I	21.8	23.8	26.0
AXES X-X S	7.27	7.93	8.67
AXES X-X r	2.46	2.36	2.28
AXES Y-Y I	1.8	2.1	2.3
AXES Y-Y S	1.1	1.2	1.3
AXES Y-Y r	.72	.69	.68
Coef. Str.	87200	95200	104000
Max. Mom." #	130800	142800	156000
V	16600	24700	34500
P. feet	2.63	1.93	1.51
R	16600	24700	34500
W	10350	11900	11900
Q. feet	4.21	4.00	4.37
w. lbs.	6	6	6
Rivet dia.	⅝	⅝	⅝

Live Load Deflection must not exceed 1-360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
2	33.2	33.2	47.6	47.6	52.0	52.0	
3	29.1	29.1	31.7	31.7	34.7	34.7	.028
4	21.8	21.8	23.8	23.8	26.0	26.0	.050
5	17.4	16.6	19.0	18.3	20.8	20.2	.078
6	14.5	13.1	15.9	14.5	17.3	16.0	.112
7	12.5	10.5	13.6	11.6	14.9	13.0	.152
8	10.9	8.5	11.9	9.5	13.0	10.6	.198
9	9.7	7.1	10.6	7.9	11.6	8.9	.252
10	8.7	5.9	9.5	6.6	10.4	7.4	.310
11	7.9	5.0	8.7	5.6	9.5	6.3	.375
12	7.3	...	7.9	...	8.7	...	.447
13	6.7	...	7.3	...	8.0	...	.525
14	6.2	...	6.8	...	7.4	...	.608
15	5.8	...	6.3	...	6.9	...	.698
16	5.5	...	6.0	...	6.5	...	.795
17	5.1	...	5.6	...	6.1	...	.898
18	4.8	...	5.3	...	5.8	...	1.01
19	4.6	...	5.0	...	5.5	...	1.12
20	4.4	...	4.8	...	5.2	...	1.24
21	4.2	...	4.5	...	5.0	...	1.37
22	4.0	...	4.3	...	4.7	...	1.51
23	3.8	...	4.1	...	4.5	...	1.64
24	3.6	...	4.0	...	4.3	...	1.79
25	3.5	...	3.8	...	4.2	...	1.94

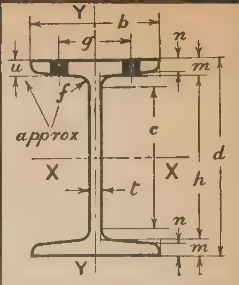
7" I

STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



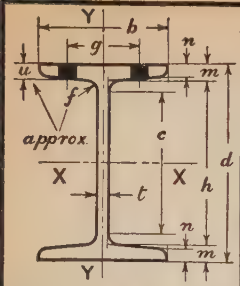
Depth = d"	7	7	7
Wt. per foot	**15.3**	17.5	20.0
Area, sq. in.	4.43	5.09	5.83
b"	3.66	3.76	3.86
t	.250	.345	.450
h	5.936	5.936	5.936
m	.534	.534	.534
n	.250	.250	.250
f	.35	.35	.35
c	5.339	5.339	5.339
g	2¼	2¼	2¼
u	⅜	⅜	⅜
AXES X-X I	36.2	38.9	41.9
AXES X-X S	10.34	11.11	11.97
AXES X-X r	2.86	2.77	2.68
AXES Y-Y I	2.7	2.9	3.1
AXES Y-Y S	1.5	1.6	1.6
AXES Y-Y r	0.78	0.76	0.74
Coef. Str.	124100	133400	143700
Max.Mom." *	186200	200100	215500
V	21000	29000	37800
P. feet	2.95	2.30	1.90
R	19700	27200	35400
W	11250	11900	11900
Q. feet	5.52	5.60	6.04
w. lbs.	6	6	6
Rivet dia.	⅝	⅝	⅝

Live Load Deflection must not exceed 1-360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	15.3 Laterally fixed	15.3 Laterally free	17.5 Laterally fixed	17.5 Laterally free	20.0 Laterally fixed	20.0 Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
2	42.0	42.0	58.0	58.0	71.9	71.9	
3	41.4	41.4	44.5	44.5	47.9	47.9	.024
4	31.0	31.0	33.4	33.4	36.0	36.0	.043
5	24.8	24.3	26.7	26.3	28.7	28.5	.067
6	20.7	19.3	22.2	20.9	24.0	22.7	.096
7	17.7	15.6	19.1	17.0	20.5	18.4	.130
8	15.5	12.8	16.7	14.0	18.0	15.3	.170
9	13.8	10.7	14.8	11.6	16.0	12.7	.216
10	12.4	9.0	13.3	9.8	14.4	10.8	.266
11	11.3	7.6	12.1	8.3	13.1	9.2	.321
12	10.3	6.4	11.1	7.1	12.0	7.9	.383
13	9.5	...	10.3	...	11.1	...	.450
14	8.9	...	9.5	...	10.3	...	.521
15	8.3	...	8.9	...	9.6	...	.599
16	7.7	...	8.3	...	9.0	...	.681
17	7.3	...	7.8	...	8.5	...	.770
18	6.9	...	7.4	...	8.0	...	.861
19	6.5	...	7.0	...	7.6	...	.960
20	6.2	...	6.7	...	7.2	...	1.06
21	5.9	...	6.4	...	6.8	...	1.17
22	5.6	...	6.1	...	6.5	...	1.29
23	5.4	...	5.8	...	6.2	...	1.41
24	5.2	...	5.6	...	6.0	...	1.53
25	5.0	...	5.3	...	5.7	...	1.66



STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

8" I

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

Depth = d"	8	8	8	8
Wt. per foot	18.4	20.5	23.0	25.5
Area, sq. in.	5.34	5.97	6.71	7.43
b"	4.00	4.08	4.17	4.26
t	.270	.349	.441	.532
h	6.838	6.838	6.838	6.838
m	.581	.581	.581	.581
n	.270	.270	.270	.270
f	.37	.37	.37	.37
c	6.211	6.211	6.211	6.211
g	2¼	2¼	2¼	2¼
u	7/16	7/16	7/16	½
AXES X-X I	56.9	60.2	64.2	68.1
AXES X-X S	14.22	15.05	16.05	17.02
AXES X-X r	3.26	3.18	3.09	3.03
AXES Y-Y I	3.8	4.0	4.4	4.7
AXES Y-Y S	1.9	2.0	2.1	2.2
AXES Y-Y r	0.84	0.82	0.81	0.80
Coef. Str.	170700	180600	192600	204300
Max. Mom." #	256100	270900	288900	306450
V	25900	33500	42300	51100
P. feet	3.30	2.70	2.28	2.00
R	22300	28800	36400	43900
W	23800	23800	23800	23800
Q. feet	3.59	3.79	4.05	4.29
w. lbs.	13	13	13	13
Rivet dia.	¾	¾	¾	¾

Live Load Deflection must not exceed 1-360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
2	51.8	51.8	67.0	67.0	84.6	84.6			
3	51.8	51.8	60.2	60.2	64.2	64.2	68.1	68.1	
4	42.7	42.7	45.2	45.2	48.2	48.2	51.1	51.1	.037
5	34.1	34.1	36.1	36.1	38.5	38.5	40.9	40.9	.058
6	28.5	27.2	30.1	28.9	32.1	31.0	34.1	33.1	.084
7	24.4	22.2	25.8	23.7	27.5	25.4	29.2	27.2	.114
8	21.3	18.4	22.6	19.7	24.1	21.2	25.5	22.6	.149
9	19.0	15.5	20.1	16.5	21.4	17.8	22.7	19.1	.189
10	17.1	13.1	18.1	14.0	19.3	15.2	20.4	16.2	.233
11	15.5	11.1	16.4	11.9	17.5	13.0	18.6	14.0	.281
12	14.2	9.6	15.1	10.3	16.1	11.2	17.0	12.0	.335
13	13.1	8.3	13.9	8.9	14.8	9.7	15.7	10.4	.394
14	12.2	...	12.9	...	13.8	...	14.6	9.1	.456
15	11.4	...	12.0	...	12.8	...	13.6	...	.524
16	10.7	...	11.3	...	12.0	...	12.8	...	.596
17	10.0	...	10.6	...	11.3	...	12.0	...	.674
18	9.5	...	10.0	...	10.7	...	11.4	...	.754
19	9.0	...	9.5	...	10.1	...	10.8	...	.840
20	8.5	...	9.0	...	9.6	...	10.2	...	.931
21	8.1	...	8.6	...	9.2	...	9.7	...	1.03
22	7.8	...	8.2	...	8.8	...	9.3	...	1.13
23	7.4	...	7.9	...	8.4	...	8.9	...	1.23
24	7.1	...	7.5	...	8.0	...	8.5	...	1.34
25	6.8	...	7.2	...	7.7	...	8.2	...	1.46

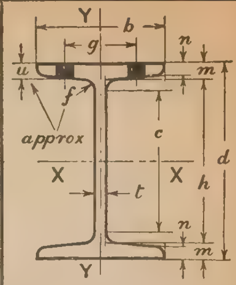
9" I

STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

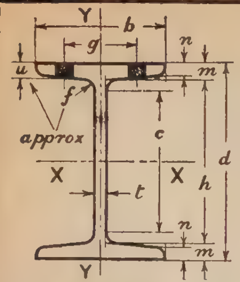
Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



Depth = d"	9	9	9	9	
Wt. per foot. .	**21.8**	25.0	30.0	35.0	
Area. sq. in. . .	6.32	7.28	8.76	10 22	
b".	4.33	4.44	4.60	4.76	
t.	.290	.397	.561	.724	
h.	7.746	7.746	7.746	7.746	
m.	.627	.627	.627	.627	
n.	.290	.290	.290	.290	
f.	.39	.39	.39	.39	
c.	7.085	7.085	7.085	7.085	
g.	2½	2½	2½	2½	
u.	½	½	½	½	
AXES X-X I.	84.9	91.4	101.4	111.3	Live Load Deflection must not exceed 1-360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
AXES X-X S.	18.87	20.31	22.53	24.73	
AXES X-X r.	3.67	3.54	3.40	3.30	
AXES Y-Y I.	5.2	5.6	6.4	7.3	
AXES Y-Y S.	2.4	2.5	2.8	3.0	
AXES Y-Y r.	0.90	0.88	0.85	0.84	
Coef. Str.	226400	243700	270400	296800	
Max.Mom." #	339600	365600	405600	445 200	
V.	31300	42900	60600	78200	
P. feet. . . .	3.62	2.84	2.23	1.90	
R.	25000	34200	48400	62400	
W.	23800	23800	23800	23800	
Q. feet. . . .	4.76	5.12	5.68	6.24	
w. lbs. . . .	13	13	13	13	
Rivet dia.	¾	¾	¾	¾	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam
3	62.6	62.6	81.2	81.2	90.1	90.1	98.9	98.9	
4	56.6	56.6	60.9	60.9	67.6	67.6	74.2	74.2	.033
5	45.3	45.3	48.7	48.7	54.1	54.1	59.4	59.4	.052
6	37.7	36.8	40.6	39.9	45.1	44.7	49.5	49.4	.074
7	32.3	30.2	34.8	32.8	38.6	36.7	42.4	40.7	.101
8	28.3	25.2	30.5	27.5	33.8	30.8	37.1	34.2	.132
9	25.2	21.4	27.1	23.2	30.0	26.1	33.0	29.2	.168
10	22.6	18.1	24.4	19.9	27.0	22.4	29.7	25.0	.207
11	20.6	15.6	22.2	17.1	24.6	19.3	27.0	21.7	.250
12	18.9	13.5	20.3	14.8	22.5	16.8	24.7	18.8	.298
13	17.4	11.7	18.7	12.9	20.8	14.7	22.8	16.5	.350
14	16.2	. . .	17.4	11.3	19.3	12.9	21.2	14.5	.406
15	15.1	. . .	16.2	. . .	18.0	11.3	19.8	12.8	.466
16	14.2	. . .	15.2	. . .	16.9	. . .	18.6	. . .	.530
17	13.3	. . .	14.3	. . .	15.9	. . .	17.5	. . .	.599
18	12.6	. . .	13.5	. . .	15.0	. . .	16.5	. . .	.670
19	11.9	. . .	12.8	. . .	14.2	. . .	15.6	. . .	.747
20	11.3	. . .	12.2	. . .	13.5	. . .	14.8	. . .	.828
21	10.8	. . .	11.6	. . .	12.9	. . .	14.1	. . .	.912
22	10.3	. . .	11.1	. . .	12.3	. . .	13.5	. . .	1.00
23	9.8	. . .	10.6	. . .	11.8	. . .	12.9	. . .	1.10
24	9.4	. . .	10.2	. . .	11.3	. . .	12.4	. . .	1.19
25	9.1	. . .	9.7	. . .	10.8	. . .	11.9	. . .	1.29



STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

10" I

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

Depth = d"		10	10	10	10
Wt. per foot		25.4	30.0	35.0	40.0
Area. sq. in.		7.38	8.75	10.22	11.69
b"		4.66	4.80	4.94	5.09
t		.310	.447	.594	.741
h		8.654	8.654	8.654	8.654
m		.673	.673	.673	.673
n		.310	.310	.310	.310
f		.41	.41	.41	.41
c		7.959	7.959	7.959	7.959
g		2¾	2¾	2¾	2¾
u		½	½	½	½
AXES X-X	I	122.1	133.5	145.8	158.0
	S	24.42	26.70	29.16	31.60
	r	4.07	3.91	3.78	3.68
AXES Y-Y	I	6.9	7.6	8.5	9.4
	S	3.0	3.2	3.4	3.7
	r	0.97	0.93	0.91	0.90
Coef. Str.		293000	320400	349900	379200
Max. Mon." *		439600	480600	524900	568800
V		37200	53600	71300	88900
P. feet		3.94	2.99	2.45	2.13
R		27900	40200	53500	66700
W		23800	23800	23800	23800
Q. feet		6.16	6.73	7.35	7.97
w. lbs.		13	13	13	13
Rivet dia.		¾	¾	¾	¾

Live Load Deflection must not exceed 1-360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
3	74.4	74.4	106	106	116	116	126	126	
4	73.3	73.3	80.1	80.1	87.5	87.5	94.8	94.8	.030
5	58.6	58.6	64.1	64.1	70.0	70.0	75.8	75.8	.047
6	48.8	48.4	53.4	53.4	58.3	58.3	63.2	63.2	.067
7	41.9	40.0	45.8	44.1	50.0	48.5	54.2	53.0	.091
8	36.6	33.6	40.1	37.1	43.7	40.9	47.4	44.7	.119
9	32.6	28.6	35.6	31.6	38.9	34.9	42.1	38.2	.151
10	29.3	24.5	32.0	27.1	35.0	30.0	37.9	32.9	.186
11	26.6	21.1	29.1	23.5	31.8	26.0	34.5	28.7	.225
12	24.4	18.4	26.7	20.5	29.2	22.8	31.6	25.1	.268
13	22.5	16.0	24.6	17.9	26.9	19.9	29.2	22.1	.315
14	20.9	14.1	22.9	15.8	25.0	17.6	27.1	19.5	.365
15	19.5	12.4	21.4	14.0	23.3	15.6	25.3	17.3	.419
16	18.3	...	20.0	12.3	21.9	13.9	23.7	15.4	.477
17	17.2	...	18.8	...	20.6	...	22.3	...	.539
18	16.3	...	17.8	...	19.4	...	21.1	...	.603
19	15.4	...	16.9	...	18.4	...	20.0	...	.672
20	14.7	...	16.0	...	17.5	...	19.0	...	.745
21	14.0	...	15.3	...	16.7	...	18.1	...	.821
22	13.3	...	14.6	...	15.9	...	17.2	...	.901
23	12.7	...	13.9	...	15.2	...	16.5	...	.986
24	12.2	...	13.4	...	14.6	...	15.8	...	1.07
25	11.7	...	12.8	...	14.0	...	15.2	...	1.16

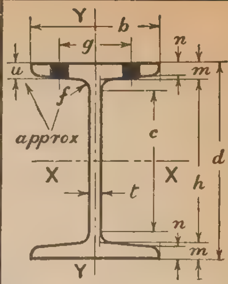
12″ I

STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½″ bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflection 80% of those shown

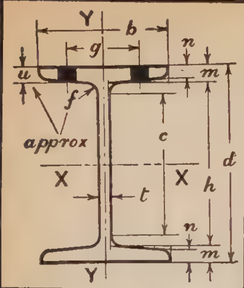


Depth = d″	12	12	12	12	12	12
Wt. per foot	**31.8**	35.0	**40.8**	45.0	50.0	55.0
Area, sq. in.	9.26	10.20	11.84	13.10	14.57	16.04
b″	5.00	5.08	5.25	5.36	5.48	5.60
t	.350	.428	.460	.565	.687	.810
h	10.524	10.524	10.282	10.282	10.282	10.282
m	.738	.738	.859	.859	.859	.859
n	.350	.350	.460	.460	.460	.460
f	.45	.45	.56	.56	.56	.56
c	9.762	9.762	9.333	9.333	9.333	9.333
g	3″	3″	3″	3″	3½	3½
u	9/16	9/16	¾	¾	¾	¾
AXES X-X I	215.8	227.0	268.9	284.1	301.6	319.3
AXES X-X S	35.97	37.83	44.82	47.35	50.27	53.22
AXES X-X r	4.83	4.72	4.77	4.66	4.55	4.46
AXES Y-Y I	9.5	10.0	13.8	14.8	16.0	17.3
AXES Y-Y S	3.8	3.9	5.3	5.5	5.8	6.2
AXES Y-Y r	1.01	0.99	1.08	1.06	1.05	1.04
Coef. Str.	431600	454000	537800	568200	603200	638600
Max. Mom.″ #	647400	681000	806700	852300	904800	957900
V	50400	61600	66200	81400	98900	116600
P. feet	4.28	3.68	4.06	3.49	3.05	2.74
R	34100	41700	44900	55100	67000	79000
W	23860	23860	23860	23860	23860	23860
Q. feet	9.04	9.51	11.27	11.91	12.64	13.38
w. lbs.	13	13	13	13	13	13
Rivet dia.	¾	¾	¾	¾	¾	¾

Live Load Deflection must not exceed 1-360 of the Span.
Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
3	101	101	123	123	132	132	163	163	198	198	213	213	
4	101	101	114	114	132	132	142	142	151	151	160	160	
5	86	86	91	91	108	108	114	114	121	121	128	128	.039
6	72	72	76	76	90	90	95	95	101	101	106	106	.056
7	62	60	65	64	77	76	81	80	86	85	91	91	.076
8	54	51	57	54	67	64	71	68	75	72	80	78	.099
9	48	43	50	45	60	55	63	58	67	62	71	67	.126
10	43	37	45	39	54	48	57	51	60	54	64	58	.155
11	39	32	41	34	49	41	52	44	55	47	58	50	.188
12	36	28	38	30	45	36	47	38	50	41	53	44	.223
13	33	25	35	26	41	32	44	34	46	36	49	39	.263
14	31	22	32	23	38	28	41	31	43	33	46	35	.304
15	29	20	30	21	36	25	38	27	40	29	43	32	.341
16	27	17	28	18	34	23	36	24	38	26	40	28	.398
17	25	...	27	...	32	20	33	21	35	23	38	25	.449
18	24	...	25	...	30	...	32	...	34	21	35	22	.503
19	23	...	24	...	28	...	30	...	32	...	34	...	.560
20	22	...	23	...	27	...	28	...	30	...	32	...	.621
21	21	...	22	...	26	...	27	...	29	...	30	...	.684
22	20	...	21	...	24	...	26	...	27	...	29	...	.751
23	19	...	20	...	23	...	25	...	26	...	28	...	.822
24	18	...	19	...	22	...	24	...	25	...	27	...	.894
25	**17**		**18**		**21**		**23**		**24**		**26**		**.970**



STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

15" I

	Depth = d"	15	15	15	15	15	15	15	15
	Wt. per foot	42.9	45.0	50.0	55.0	60.8	65.0	70.0	75.0
	Area, sq. in.	12.49	13.12	14.59	16.06	17.68	18.91	20.38	21.85
	b"	5.50	5.54	5.64	5.74	6.00	6.08	6.18	6.28
	t	.410	.452	.550	.648	.590	.672	.770	.868
	h	13.332	13.332	13.332	13.332	12.918	12.918	12.918	12.918
	m	.834	.834	.834	.834	1.041	1.041	1.041	1.041
	n	.410	.410	.410	.410	.590	.590	.590	.590
	f	.51	.51	.51	.51	.69	.69	.69	.69
	c	12.468	12.468	12.468	12.468	11.749	11.749	11.749	11.749
	g	3½	3½	3½	3½	3½	3½	3½	3½
	u	⅝	⅝	⅝	⅝	⅞	⅞	⅞	⅞
AXES X-X	I	441.8	453.6	481.1	508.7	609.0	632.1	659.6	687.2
AXES X-X	S	58.91	60.48	64.15	67.83	81.20	84.28	87.95	91.63
AXES X-X	r	5.95	5.88	5.74	5.63	5.87	5.78	5.69	5.61
AXES Y-Y	I	14.6	15.0	16.0	17.0	26.0	27.2	28.8	30.6
AXES Y-Y	S	5.3	5.4	5.7	5.9	8.7	8.9	9.3	9.8
AXES Y-Y	r	1.08	1.07	1.05	1.03	1.21	1.20	1.19	1.18
	Coef. Str.	706900	725800	769800	813900	974400	1011400	1055400	1099500
	Max. Mom." #	1060300	1088600	1154600	1220900	1461600	1517000	1583000	1649300
	V	73800	81400	99000	116600	106200	121000	138600	156200
	P. feet	4.79	4.46	3.89	3.49	4.59	4.18	3.81	3.52
	R	43800	49200	59800	70500	64200	73100	83700	94400
	W	36900	40700	47700	47700	47700	47700	47700	47700
	Q feet	9.58	8.92	8.07	8.53	10.21	10.60	11.06	11.53
	w. lbs.	19	19	19	19	19	19	19	19
	Rivet dia.	¾	¾	¾	¾	¾	¾	¾	¾

Live Load Deflection must not exceed 1-360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	42.9 Laterally fixed	42.9 Laterally free	45.0 Laterally fixed	45.0 Laterally free	50.0 Laterally fixed	50.0 Laterally free	55.0 Laterally fixed	55.0 Laterally free	60.8 Laterally fixed	60.8 Laterally free	65.0 Laterally fixed	65.0 Laterally free	70.0 Laterally fixed	70.0 Laterally free	75.0 Laterally fixed	75.0 Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
4	148	148	163	163	192	192	204	204	212	212	242	242	264	264	275	275	
5	141	141	145	145	154	154	163	163	195	195	202	202	211	211	220	220	.031
6	118	118	121	121	128	128	136	136	162	162	169	169	176	176	183	183	.045
7	101	100	104	104	110	110	116	116	139	139	145	145	151	151	157	157	.061
8	88	85	91	88	96	93	102	99	122	120	126	124	132	131	137	136	.079
9	79	74	81	76	86	81	90	85	108	103	112	108	117	113	122	118	.101
10	71	64	73	66	77	70	81	74	97	90	101	94	106	99	110	103	.124
11	64	55	66	57	70	61	74	65	89	80	92	83	96	87	100	91	.150
12	59	49	60	50	64	54	68	57	81	70	84	73	88	77	92	81	.179
13	54	43	56	45	59	47	63	51	75	62	78	65	81	68	85	72	.210
14	50	38	52	40	55	42	58	45	70	56	72	58	75	61	79	65	.243
15	47	34	48	35	51	38	54	40	65	50	67	52	70	55	73	58	.279
16	44	30	45	31	48	34	51	36	61	45	63	46	66	50	69	52	.318
17	42	28	43	28	45	30	48	33	57	40	59	42	62	45	65	47	.359
18	39	24	40	25	43	28	45	29	54	36	56	39	59	41	61	43	.402
19	37	...	38	...	41	...	43	27	51	33	53	35	56	37	58	39	.448
20	35	...	36	...	38	...	41	...	49	30	51	32	53	34	55	35	.497
21	34	...	35	...	37	...	39	...	46	...	48	...	50	...	52	...	.547
22	32	...	33	...	35	...	37	...	44	...	46	...	48	...	50	...	.601
23	31	...	32	...	33	...	35	...	42	...	44	...	46	...	48	...	.651
24	29	...	30	...	32	...	34	...	41	...	42	...	44	...	46	...	.715
25	28	...	29	...	31	...	33	...	39	...	40	...	42	...	44	...	.776
26	27	...	28	...	30	...	31	...	37	...	39	...	41	...	42	...	.839
27	26	...	27	...	29	...	30	...	36	...	37	...	39	...	41	...	.905
28	25	...	26	...	27	...	29	...	35	...	36	...	38	...	39	...	.973
29	24	...	25	...	27	...	28	...	34	...	35	...	36	...	38	...	1.040
30	24	...	24	...	26	...	27	...	32	...	34	...	35	...	37	...	1.120

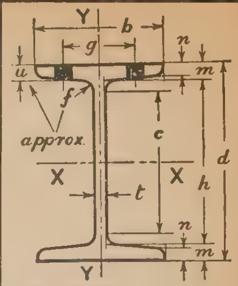
18" I

STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

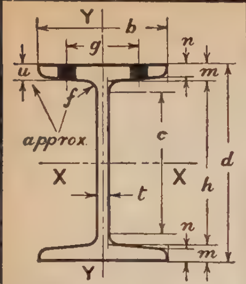


Depth = d"	18	18	18	18	18	18	18	18
Wt. per foot	54.7	60.0	65.0	70.0	75.6	80.0	85.0	90.0
Area, sq. in.	15.94	17.50	18.98	20.46	22.04	23.34	24.81	26.29
b"	6.00	6.09	6.17	6.25	7.00	7.07	7.15	7.24
t	.460	.547	.629	.711	.560	.632	.714	.796
h	16.156	16.156	16.156	16.156	15.610	15.610	15.610	15.610
m	.922	.922	.922	.922	1.195	1.195	1.195	1.195
n	.460	.460	.460	.460	.659	.659	.659	.659
f	.56	.56	.56	.56	.66	.66	.66	.66
c	15.207	15.207	15.207	15.207	14.492	14.492	14.492	14.492
g	3¾	3¾	3¾	3¾	4"	4"	4"	4"
u	¾	¾	¾	¾	1"	1"	1"	1"
AXES X-X I	795.5	837.8	877.7	917.5	1141.8	1176.8	1216.6	1256.5
AXES X-X S	88.39	93.09	97.53	101.94	126.87	130.76	135.18	139.61
AXES X-X r	7.07	6.92	6.80	6.70	7.20	7.10	7.00	6.91
AXES Y-Y I	21.2	22.3	23.4	24.5	46.3	47.9	49.8	51.9
AXES Y-Y S	7.1	7.3	7.6	7.8	13.2	13.6	14.0	14.3
AXES Y-Y r	1.15	1.13	1.11	1.09	1.45	1.43	1.42	1.40
Coef. Str.	1060700	1117100	1170300	1223300	1522400	1569100	1622100	1675300
Max. Mom." #	1591000	1675600	1755400	1835000	2283600	2353600	2433200	2513000
V	99400	118200	135900	153600	121000	136500	154200	171900
P. feet	5.34	4.73	4.31	3.98	6.29	5.75	5.26	4.88
R	52800	65600	75500	85300	67200	75800	85700	95500
W	41400	47700	47700	47700	47700	47700	47700	47700
Q. feet	12.81	11.71	12.27	12.82	15.96	16.45	17.00	17.56
w. lbs.	19	19	19	19	19	19	19	19
Rivet dia.	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞

Live Load Deflection must not exceed 1-360 of the Span.
Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	54.7 Laterally fixed	54.7 Laterally free	60.0 Laterally fixed	60.0 Laterally free	65.0 Laterally fixed	65.0 Laterally free	70.0 Laterally fixed	70.0 Laterally free	75.6 Laterally fixed	75.6 Laterally free	80.0 Laterally fixed	80.0 Laterally free	85.0 Laterally fixed	85.0 Laterally free	90.0 Laterally fixed	90.0 Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
6	177	177	186	186	195	195	204	204	242	242	262	262	270	270	279	279	.037
7	152	152	160	160	167	167	175	175	218	218	224	224	232	232	239	239	.051
8	133	131	140	138	146	145	153	152	190	190	196	196	203	203	209	209	.066
9	118	113	124	119	130	125	136	132	169	168	174	173	180	180	186	186	.084
10	106	98	112	104	117	109	122	114	152	147	157	152	162	157	168	164	.103
11	96	86	102	92	106	96	111	100	138	130	143	135	147	140	152	145	.125
12	88	76	93	81	98	86	102	90	127	116	131	121	135	125	140	130	.149
13	82	68	86	72	90	76	94	80	117	104	121	108	125	112	129	116	.175
14	76	61	80	64	84	68	87	71	109	94	112	97	116	101	120	105	.203
15	71	54	74	57	78	61	82	64	102	85	105	88	108	91	112	95	.233
16	66	49	70	52	73	55	76	57	95	77	98	80	101	83	105	86	.265
17	62	44	66	47	69	50	72	52	90	70	92	72	95	75	99	79	.299
18	59	40	62	42	65	45	68	47	85	64	87	66	90	69	93	72	.335
19	56	36	59	39	62	41	64	43	80	58	83	61	85	63	88	65	.373
20	53	33	56	35	59	37	61	39	76	53	78	55	81	58	84	60	.414
21	51	...	53	...	56	...	58	...	73	49	75	51	77	53	80	55	.456
22	48	...	51	...	53	...	56	...	69	45	71	47	74	49	76	50	.501
23	46	...	49	...	51	...	53	...	66	41	68	43	71	45	73	47	.548
24	44	...	47	...	49	...	51	...	63	...	65	...	68	...	70	43	.596
25	42	...	45	...	47	...	49	...	61	...	63	...	65	...	67	...	.647
26	41	...	43	...	45	...	47	...	59	...	60	...	62	...	64	...	.699
27	39	...	41	...	43	...	45	...	56	...	58	...	60	...	62	...	.754
28	38	...	40	...	42	...	44	...	54	...	56	...	58	...	60	...	.811
29	37	...	39	...	40	...	42	...	52	...	54	...	56	...	58	...	.870
30	35	...	37	...	39	...	41	...	51	...	52	...	54	...	56	...	.931
31	34	...	36	...	38	...	39	...	49	...	51	...	52	...	54	...	.994
32	33	...	35	...	37	...	38	...	48	...	49	...	51	...	52	...	1.06
33	32	...	34	...	35	...	37	...	46	...	48	...	49	...	51	...	1.13
34	31	...	33	...	34	...	36	...	45	...	46	...	48	...	49	...	1.20
35	30	...	32	...	33	...	35	...	44	...	45	...	46	...	48	...	1.27
36	29	...	31	...	32	...	34	...	42	...	44	...	45	...	47	...	1.34



STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

20" I

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet, uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown

Depth = d"	20	20	20	20	20	20	20	20
Wt. per foot	**65.4**	70.0	75.0	**81.4**	85.0	90.0	95.0	100.0
Area. sq. in.	19.08	20.42	21.90	23.74	24.8	26.26	27.74	29.20
b"	6.25	6.32	6.39	7.00	7.05	7.13	7.20	7.27
t	.500	.567	.641	.600	.653	.726	.800	.873
h	17.942	17.942	17.942	17.634	17.634	17.634	17.634	17.634
m	1.029	1.029	1.029	1.183	1.183	1.183	1.183	1.183
n	.550	.550	.550	.650	.650	.650	.650	.650
f	.60	.60	.60	.70	.70	.70	.70	.70
c	16.925	16.925	16.925	16.448	16.448	16.448	16.448	16.448
g	4"	4"	4"	4"	4"	4"	4"	4"
u	¾	¾	¾	1"	1"	1"	1"	1"
AXES X-X I	1169.5	1214.2	1263.5	1466.3	1501.7	1550.3	1599.7	1648.3
AXES X-X S	116.95	121.42	126.35	146.63	150.17	155.03	159.97	164.83
AXES X-X r	7.83	7.71	7.60	7.86	7.78	7.68	7.59	7.51
AXES Y-Y I	27.9	28.9	30.1	45.8	47.0	48.7	50.5	52.4
AXES Y-Y S	8.9	9.2	9.4	13.1	13.3	13.7	14.0	14.4
AXES Y-Y r	1.21	1.19	1.17	1.39	1.38	1.36	1.35	1.34
Coef. Str.	1403400	1457000	1516200	1759600	1802000	1860400	1919600	1978000
Max. Mom." #	2105100	2185600	2274300	2639300	2703100	2790500	2879500	2966900
V	120000	136100	153800	144000	156700	174200	192000	209500
P. feet	5.85	5.35	4.93	6.11	5.75	5.34	5.00	4.72
R	60400	71900	81700	76500	83300	92600	102000	111300
W	56250	59600	59600	59600	59600	59600	59600	59600
Q. feet	12.47	12.22	12.72	14.76	15.12	15.61	16.10	16.59
w. lbs.	25	25	25	25	25	25	25	25
Rivet dia.	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞

Live Load Deflection must not exceed 1-360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet

Span feet	65.4 Laterally fixed	65.4 Laterally free	70.0 Laterally fixed	70.0 Laterally free	75.0 Laterally fixed	75.0 Laterally free	81.4 Laterally fixed	81.4 Laterally free	85.0 Laterally fixed	85.0 Laterally free	90.0 Laterally fixed	90.0 Laterally free	95.0 Laterally fixed	95.0 Laterally free	100.0 Laterally fixed	100.0 Laterally free	Total Deflection in inches for Maximum Load; laterally fixed beam.
6	234	234	243	243	253	253	288	288	300	300	310	310	320	320	330	330	.034
8	175	174	182	181	190	190	220	220	225	225	233	233	240	240	247	247	.060
10	140	131	146	137	152	143	176	171	180	175	186	180	192	187	198	194	.093
11	128	116	132	120	138	126	160	151	164	155	169	161	175	167	180	172	.113
12	117	103	121	107	126	112	147	135	150	138	155	143	160	148	165	153	.134
13	108	91	112	95	117	100	135	120	139	124	143	128	148	133	152	137	.158
14	100	82	104	85	108	89	126	109	129	112	133	116	137	120	141	124	.183
15	94	74	97	77	101	80	117	98	120	101	124	105	128	108	132	112	.210
16	88	66	91	69	95	73	110	89	113	92	116	95	120	98	124	102	.239
17	83	60	86	63	89	66	104	81	106	83	109	86	113	90	116	93	.270
18	78	54	81	57	84	59	98	74	100	76	103	78	107	82	110	85	.302
19	74	49	77	52	80	54	93	68	95	69	98	72	101	75	104	77	.336
20	70	45	73	47	76	50	88	62	90	63	93	66	96	69	99	71	.373
21	67	...	69	43	72	45	84	57	86	58	89	60	91	63	94	65	.411
22	64	...	66	...	69	...	80	52	82	54	85	56	87	58	90	60	.451
23	61	...	63	...	66	...	77	48	78	49	81	51	83	53	86	55	.493
24	58	...	61	...	63	...	73	...	75	...	78	...	80	49	82	51	.537
25	56	...	58	...	61	...	70	...	72	...	74	...	77	...	79	...	.582
26	54	...	56	...	58	...	68	...	69	...	72	...	74	...	76	...	.630
27	52	...	54	...	56	...	65	...	67	...	69	...	71	...	73	...	.679
28	50	...	52	...	54	...	63	...	64	...	66	...	69	...	71	...	.736
29	48	...	50	...	52	...	61	...	62	...	64	...	66	...	68	...	.783
30	47	...	49	...	51	...	59	...	60	...	62	...	64	...	66	...	.838
31	45	...	47	...	49	...	57	...	58	...	60	...	62	...	64	...	.895
32	44	...	46	...	47	...	55	...	56	...	58	...	60	...	62	...	.954
33	43	...	44	...	46	...	53	...	55	...	56	...	58	...	60	...	1.01
34	41	...	43	...	45	...	52	...	53	...	55	...	56	...	58	...	1.08
35	40	...	42	...	43	...	50	...	51	...	53	...	55	...	57	...	1.14
36	39	...	40	...	42	...	49	...	50	...	52	...	53	...	55	...	1.21
37	38	...	39	...	41	...	48	...	49	...	50	...	52	..	53	...	1.28
38	37	...	38	...	40	...	46	...	47	...	49	...	50	...	52	...	1.34

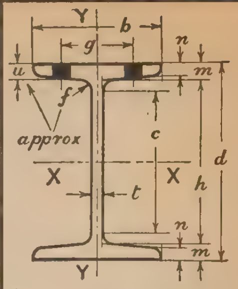
24" I

STANDARD BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia
S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds
P is Minimum Span in feet uniformly loaded to cause V
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions
W is Maximum Load on one Standard Connection
Q is Minimum Span in feet uniformly loaded to cause W
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is maximum diameter in flange
Allowable concentrated center loads are 50% and their deflections 80% of those shown



Depth = d"	24	24	24	24	24	24	24	24	24
Wt. per ft. .	**79.9**	85.0	90.0	95.0	100.0	**105.9**	110.0	115.0	120.0
Area. sq. in.	23.33	24.84	26.30	27.79	29.25	30.98	32.18	33.67	35.13
b".	7.000	7.063	7.124	7.186	7.247	7.875	7.925	7.987	8.048
t.	.500	.563	.624	.686	.747	.625	.675	.737	.798
h.	21.716	21.716	21.716	21.716	21.716	21.192	21.192	21.192	21.192
m.	1.142	1.142	1.142	1.142	1.142	1.404	1.404	1.404	1.404
n.	.60	.60	.60	.60	.60	.80	.80	.80	.80
f	.60	.60	.60	.60	.60	.60	.60	.60	.60
c.	20.699	20.699	20.699	20.699	20.699	20.175	20.175	20.175	20.175
g.	4"	4"	4"	4"	4"	5"	5"	5"	5"
u.	⅞	⅞	⅞	⅞	⅞	1 1/16	1 1/16	1 1/16	1 1/16
AXES X-X I. . .	2087.2	2159.8	2230.1	2301.5	2371.8	2811.5	2869.1	2940.5	3010.8
AXES X-X S. . .	173.93	180.00	185.84	191.80	197.65	234.30	239.10	245.04	250.90
AXES X-X r.	9.46	9.33	9.21	9.08	9.05	9.53	9.44	9.35	9.26
AXES Y-Y I. . .	42.9	44.2	45.5	47.0	48.4	78.9	80.6	82.8	84.9
AXES Y-Y S. . .	12.2	12.5	12.8	13.0	13.4	20.0	20.3	20.7	21.1
AXES Y-Y r. . .	1.36	1.33	1.32	1.30	1.29	1.60	1.58	1.57	1.56
Coef. Str. . .	2087200	2159800	2230100	2301500	2371800	2811500	2869100	2940500	3010800
Max. Mom."#	3130000	3240000	3345000	3452000	3557700	4217000	4304000	4410800	4516000
V.	144000	162100	179700	197600	215000	180000	194400	212300	229800
P. feet. .	7.25	6.66	6.20	5.82	5.51	7.80	7.38	6.92	6.55
R.	61800	73900	85700	97400	106400	85800	95400	105000	113700
W.	67500	71600	71600	71600	71600	71600	71600	71600	71600
Q. feet. .	15.5	15.1	15.6	16.1	16.6	19.6	20.0	20.5	21.0
w. lbs. . .	30	30	30	30	30	30	30	30	30
Rivet dia. . .	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞

Live Load Deflection must not exceed 1-360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span ft.	79.9 Laterally fixed	79.9 Laterally free	85.0 Laterally fixed	85.0 Laterally free	90.0 Laterally fixed	90.0 Laterally free	95.0 Laterally fixed	95.0 Laterally free	100.0 Laterally fixed	100.0 Laterally free	105.9 Laterally fixed	105.9 Laterally free	110.0 Laterally fixed	110.0 Laterally free	115.0 Laterally fixed	115.0 Laterally free	120.0 Laterally fixed	120.0 Laterally free	Total Deflection in Inches for Maximum Load; laterally fixed beam.
6	288	288	324	324	359	359	384	384	395	395	360	360	389	389	425	425	460	460	
8	261	261	270	270	279	279	288	288	296	296	352	352	359	359	368	368	376	376	.050
10	209	203	216	210	223	217	230	224	237	231	281	280	287	286	294	294	301	301	.078
12	174	160	180	166	186	172	192	178	198	184	234	223	239	228	245	234	251	241	.112
14	149	129	154	133	159	138	164	143	169	148	201	182	205	186	210	191	215	196	.152
16	130	105	135	109	139	113	144	118	148	122	176	151	179	154	184	159	188	163	.199
18	116	87	120	91	124	94	128	98	132	102	156	126	159	129	163	133	167	136	.251
20	104	73	108	76	111	79	115	82	119	85	141	107	143	109	147	113	151	116	.310
21	99	66	103	70	106	72	110	76	113	78	134	98	137	101	140	104	143	107	.342
22	95	62	98	64	101	66	105	70	108	72	128	91	130	93	134	96	137	99	.375
23	91	57	94	59	97	61	100	64	103	66	122	84	125	86	128	89	131	92	.411
24	87	...	90	...	93	...	96	59	99	62	117	78	120	80	123	83	125	85	.447
25	83	...	86	...	89	...	92	...	95	...	112	72	115	74	118	77	120	79	.485
26	80	...	83	. .	86	...	89	...	91	...	108	67	110	69	113	71	116	73	.525
27	77	...	80	. .	83	...	85	...	88	...	104	...	106	...	109	...	112	..	.566
28	74	...	77	. .	80	...	82	...	85	...	100	...	102	...	105	...	108	..	.608
29	72	...	74	...	77	...	79	...	82	...	97	...	99	...	101	...	104	..	.653
30	70	...	72	...	74	...	77	...	79	...	94	...	96	...	98	...	100	..	.698
31	67	...	70	...	72	...	74	...	77	...	91	...	93	...	95	...	97	..	.746
32	65	...	68	...	70	...	72	...	74	...	88	...	90	...	92	...	94	..	.795
33	63	...	65	...	68	...	70	...	72	...	85	...	87	...	89	...	91	..	.845
34	61	...	63	...	66	...	68	...	70	...	83	...	84	...	86	...	89	..	.897
35	60	...	62	...	64	...	66	...	68	...	80	...	82	...	84	...	86	..	.950
36	58	...	60	...	62	...	64	...	66	...	78	...	80	...	82	...	84	..	1.01
38	55	...	57	...	59	...	61	...	62	...	74	...	76	...	77	...	79	..	1.12
40	52	...	54	...	56	...	58	...	59	...	70	...	72	...	74	...	75	..	1.24
42	50	...	51	...	53	...	55	...	56	...	67	...	68	...	72	...	72	..	1.37
44	47	...	49	...	51	...	52	...	54	...	64	...	65	...	67	...	68	..	1.50
46	45	...	47	...	48	...	50	...	52	...	61	...	62	...	64	...	65	..	1.64
48	43	...	45	...	46	...	48	...	49	...	59	...	60	...	61	...	63	..	1.79
50	42	...	43	...	45	...	46	...	47	...	56	...	57	...	59	...	60	..	1.94

ALLOWABLE END REACTIONS FOR AMERICAN STANDARD BEAMS
DETERMINED BY
BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight Per Foot	Web t.	Unit Stress in Buckling	Reaction R For 3½" Bearing	Min. Span For 3½" Bearing	Reaction R For 5½" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V.	Length of Bearing to Develop V.
5	10.00	.210"	15000	12600	2.30'	12600	3150	12600	2.75"
	12.25	.347	"	20800	1.56	20800	5205	20800	"
	14.75	.494	"	29600	1.22	29600	7410	29600	"
6	12.50	.230	15000	16600	2.63	16600	3450	16600	3.31
	14.75	.343	"	24700	1.93	24700	5145	24700	3.30
	17.25	.465	"	34500	1.51	34500	6975	34500	3.45
7	15.30	.250	15000	19700	3.15	21000	3750	21000	3.85
	17.50	.345	"	27200	2.45	29000	5175	29000	"
	20.00	.450	"	35400	2.03	37800	6750	37800	"
8	18.40	.270	15000	22300	3.83	25900	4050	25900	4.39
	20.50	.349	"	28800	3.13	33500	5235	33500	"
	23.00	.441	"	36400	2.65	42300	6615	42300	"
	25.50	.532	"	43900	2.33	51100	7980	51100	4.40
9	21.80	.290	15000	25000	4.52	31300	4350	31300	4.95
	25.00	.397	"	34200	3.56	42900	5955	42900	"
	30.00	.561	"	48400	2.79	60600	8415	60600	"
	35.00	.724	"	62400	2.38	78200	10860	78200	"
10	25.40	.310	15000	27900	5.25	37200	4650	37200	5.50
	30.00	.447	"	40200	3.98	53600	6705	53600	"
	35.00	.594	"	53500	3.27	71300	8910	71300	"
	40.00	.741	"	66700	2.84	88900	11115	88900	"
12	31.80	.350	15000	34100	6.32	44600	5250	50400	6.60
	35.00	.428	"	41700	5.44	54600	6420	61600	"
	40.80	.460	"	44900	5.99	58700	6900	66200	"
	45.00	.565	"	55100	5.16	72000	8475	81400	6.60
	50.00	.687	"	67000	4.50	87600	10305	98900	"
	55.00	.810	"	79000	4.04	103300	12150	116600	"
15	42.90	.410	14730	43800	8.07	55900	6035	73800	8.47
	45.00	.452	15000	49200	7.38	62700	6780	81400	8.25
	50.00	.550	"	59800	6.43	76300	8250	99000	"
	55.00	.648	"	70500	5.77	89900	9720	116600	"
	60.80	.590	15000	64200	7.59	81900	8850	106200	8.25
	65.00	.672	"	73100	6.92	93200	10080	121000	"
	70.00	.770	"	83700	6.30	106800	11550	138600	"
	75.00	.868	"	94400	5.82	120400	13020	156200	"
18	54.70	.460	14350	52800	10.07	66000	6600	99400	10.55
	60.00	.547	15000	65600	8.51	82100	8205	118200	9.90
	65.00	.629	"	75500	7.75	94400	9435	135900	"
	70.00	.711	"	85300	7.17	106700	10665	153600	"
	75.60	.560	15000	67200	11.33	84000	8400	121000	9.90
	80.00	.632	"	75800	10.35	94800	9480	136500	"
	85.00	.714	"	85700	9.47	107100	10710	154200	"
	90.00	.796	"	95500	8.78	119400	11940	171900	"
20	65.40	.500	14210	60400	11.63	74600	7105	120000	11.88
	70.00	.567	14910	71900	10.14	88800	8450	136100	11.11
	75.00	.641	15000	81700	9.28	101000	9615	153800	11.00
	81.40	.600	"	76500	11.50	94500	9000	144000	"
	85.00	.653	15000	83300	10.82	102800	9795	156700	11.00
	90.00	.726	"	92600	10.05	114300	10890	174200	"
	95.00	.800	"	102000	9.41	126000	12000	192000	"
	100.00	.873	"	111300	8.88	137500	13095	209500	"
24	79.90	.500	13010	61800	16.89	74800	6505	144000	16.10
	85.00	.563	13820	73900	14.61	89500	7780	162100	14.84
	90.00	.624	14450	85700	13.02	103700	9015	179700	13.94
	95.00	.686	14950	97400	11.81	117900	10255	197600	13.26
	100.00	.747	15000	106400	11.14	128900	11205	215000	13.19
	105.90	.625	14450	85800	16.38	104400	9030	180000	13.93
	110.00	.675	14870	95400	15.04	115400	10035	194400	13.37
	115.00	.737	15000	105000	14.00	127100	11055	212300	13.20
	120.00	.798	"	113700	13.24	137700	11970	229800	13.20

The beam web is treated as a column with fixed ends, having an effective length l of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.

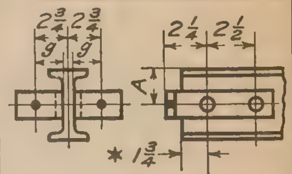
When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

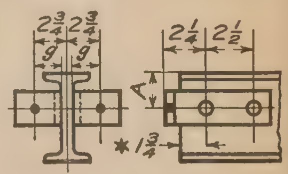
CONNECTION ANGLES FOR AMERICAN STANDARD BEAMS

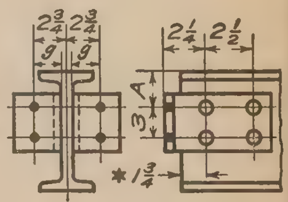
DIMENSIONS, WEIGHTS, AND WORKING LOADS — **3/4″ POWER DRIVEN RIVETS**

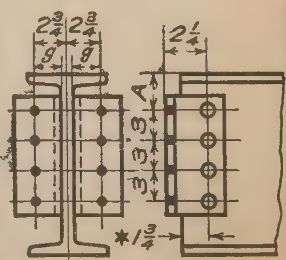
Beam: Depth	Beam: Weight per foot	Connection Value: Web	Outstanding Single Shear: Power Driven Rivets	Outstanding Single Shear: Unfinished Bolts	Framing Distance C	Connection Angles: A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets
3″	5.7	7650	11930	8840	1/8	IC. 5.11	2 11/16	6″ × 4″ × 3/8″ 0′ — 2″ Long	5 lbs.
	6.5	11296	"	"	3/16	IC. 5.10	2 5/8		
	7.5	15706	"	"	1/4	IC. 5. 9	2 9/16		
4″	7.7	8550	11930	8840	3/16	IC. 5.10	2 5/8		
	8.5	11390	"	"	3/16	IC. 5.10	2 5/8		
	9.5	14670	"	"	1/4	IC. 5. 9	2 9/16		
	10.5	18000	"	"	1/4	IC. 5. 9	2 9/16		
5″	10.0	9450	11930	8840	3/16	IC. 6.10	2 5/8	6″ × 4″ × 3/8″ 0′ — 2½″ Long	6 lbs.
	12.25	15620	"	"	1/4	IC. 6. 9	2 9/16		
	14.75	22230	"	"	5/16	IC. 6. 8	2 1/2		
6″	12.5	10350	11930	8840	3/16	IC. 6.10	2 5/8		
	14.75	15440	"	"	1/4	IC. 6. 9	2 9/16		
	17.25	20930	"	"	5/16	IC. 6. 8	2 1/2		
7″	15.3	11250	11930	8840	3/16	IC. 6.10	2 5/8		
	17.5	15530	"	"	1/4	IC. 6. 9	2 9/16		
	20.0	20250	"	"	5/16	IC. 6. 8	2 1/2		
8″	18.4	24300	23860	17670	3/16	IC.13.10	2 5/8	6″ × 4″ × 3/8″ 0′ — 5½″ Long	13 lbs.
	20.5	31410	"	"	1/4	IC.13. 9	2 9/16		
	23.0	39690	"	"	5/16	IC.13. 8	2 1/2		
	25.5	47720	"	"	5/16	IC.13. 8	2 1/2		
9″	21.8	26100	23860	17670	3/16	IC.13.10	2 5/8		
	25.0	35730	"	"	1/4	IC.13. 9	2 9/16		
	30.0	47720	"	"	3/8	IC.13. 8	2 1/2		
	35.0	"	"	"	7/16	IC.13. 6	2 3/8		
10″	25.4	27900	23860	17670	1/4	IC.13.10	2 5/8		
	30.0	40230	"	"	5/16	IC.13. 8	2 1/2		
	35.0	47720	"	"	3/8	IC.13. 7	2 7/16		
	40.0		"	"	7/16	IC.13. 6	2 3/8		
12″	31.8	31500	23860	17670	1/4	IC.13. 9	2 9/16		
	35.0	38520	"	"	1/4	IC.13. 9	2 9/16		
	40.8	41400	"	"	5/16	IC.13. 8	2 1/2		
	45.0	47720	"	"	3/8	IC.13. 7	2 7/16		
	50.0	"	"	"	7/16	IC.13. 6	2 3/8		
	55.0	"	"	"	1/2	IC.13. 6	2 3/8		
15″	42.9	36900	47720	35340	1/4	IC.19. 9	2 9/16	4″ × 3½″ × 3/8″ 0′ — 11½″ Long	19 lbs.
	45.0	40680	"	"	5/16	IC.19. 8	2 1/2		
	50.0	47720	"	"	5/16	IC.19. 8	2 1/2		
	55.0	"	"	"	3/8	IC.19. 7	2 7/16		
	60.8	47720	47720	35340	3/8	IC.19. 7	2 7/16		
	65.0	"	"	"	3/8	IC.19. 7	2 7/16		
	70.0	"	"	"	7/16	IC.19. 6	2 3/8		
	75.0	"	"	"	1/2	IC.19. 5	2 5/16		
18″	54.7	41400	47720	35340	5/16	IC.19. 8	2 1/2		
	60.0	47720	"	"	5/16	IC.19. 8	2 1/2		
	65.0	"	"	"	3/8	IC.19. 7	2 7/16		
	70.0	"	"	"	7/16	IC.19. 6	2 3/8		
	75.6	47720	47720	35340	3/8	IC.19. 8	2 1/2		
	80.0	"	"	"	3/8	IC.19. 7	2 7/16		
	85.0	"	"	"	7/16	IC.19. 6	2 3/8		
	90.0	"	"	"	7/16	IC.19. 6	2 3/8		

Connection Details.



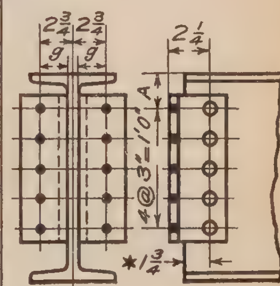
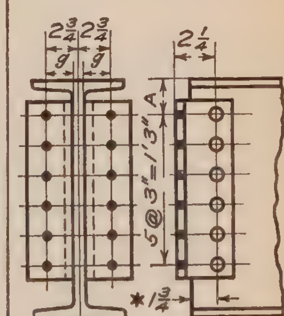


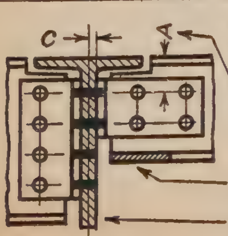




CONNECTION ANGLES FOR AMERICAN STANDARD BEAMS

DIMENSIONS, WEIGHTS AND WORKING LOADS. **3/4″ POWER DRIVEN RIVETS.**

Beam		Connection Value			Framing Distance	Connection Angles				Connection Details.
			Outstanding Single Shear							
Depth	Weight per foot	Web	Power Driven Rivets	Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	
20″	65.4	56250	59650	44180	5/16	IC.25.8	2 1/2	4″ × 3½″ × 3/8″ 1′ — 2½″ Long	25 lbs.	
	70.0	59650	"	"	3/8	IC.25.7	2 7/16			
	75.0	"	"	"	3/8	IC.25.7	2 7/16			
	81.4	"	"	"	3/8	IC.25.7	2 7/16			
	85.0	59650	59650	44180	3/8	IC.25.7	2 7/16			
	90.0	"	"	"	7/16	IC.25.6	2 3/8			
	95.0	"	"	"	7/16	IC.25.6	2 3/8			
	100.0	"	"	"	1/2	IC.25.5	2 5/16			
24″	79.9	67500	71580	53020	5/16	IC.30.8	2 1/2	4″ × 3½″ × 3/8″ 1′ — 5½″ Long	30 lbs.	
	85.0	71580	"	"	3/8	IC.30.7	2 7/16			
	90.0	"	"	"	3/8	IC.30.7	2 7/16			
	95.0	"	"	"	7/16	IC.30.7	2 7/16			
	100.0	71580	71580	53020	7/16	IC.30.6	2 3/8			
	105.9	"	"	"	3/8	IC.30.7	2 7/16			
	110.0	"	"	"	3/8	IC.30.7	2 7/16			
	115.0	"	"	"	7/16	IC.30.6	2 3/8			
	120.0	"	"	"	7/16	IC.30.6	2 3/8			



*Layer-out starts with this dimension at left end of beam. With beams ordered one inch short, as usual in standard shop practice, this leaves sufficient end distance or clearance at right end, in case of full allowable 3/8″ underrun or 3/8″ overrun in beam lengths.

When A = 3″ all beams and channels from 24″ 100 lb. to 5″ inclusive, can be framed opposite with tops flush.

When A = 3¼″ all beams and channels from 24″ 120 lb. to 6″ inclusive, excepting 8″; can be framed opposite with tops flush.

Flange must be cut away as shown, for field riveting, on all beams (excepting 5″ and 8″) framing opposite a larger beam which has a different size standard connection.

Minimum Web required to develop Single Shearing Value is .33″
Minimum Web required to develop Double Shearing Value is .53″

BEAM SUMMARY

Pages 308—312

The beam summary affords the quickest and easiest method of selecting the most economical beam section to use for any total continuous uniformly distributed load and any span in feet.

A.I.S.C. CONNECTION ANGLES

The A. I. S. C. mark on drawings gives useful information without further reference to a connection angle chart. The figures, immediately following the Institute's symbol IC, are the weight of the connection, including the web rivets, and the last figures are the number of sixteenths of an inch greater than 2″ in the gauge of the outstanding legs. Thus, connection angles IC.49.7 weigh 49 pounds, including web rivets, and the gauge in the outstanding leg is $2\frac{7}{16}$″. A further discussion on the A. I. S. C. connection angle appears on page 179.

Part IV
Section 5

Bethlehem Beams

Dimensions

Technical Functions

Allowable Total Loads
by
A. I. S. C. Specification

Allowable End Reactions

Standard Connection Angles

Usual Stock Sizes	
Depth	Weight
8″	17.5 #
9	20.5
10	23.5
12	28.0
14	33.0
15	38.5
16	40.0
18	49.0
20	59.5
22	62.5
24	73.5
26	91.0
28	97.0
30	121.0
33	135.0
36	155.0

8" B

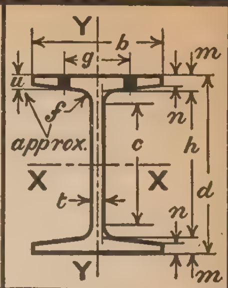
BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration

V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



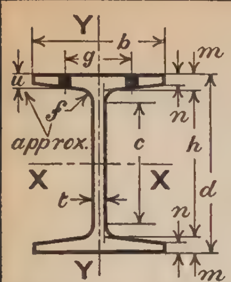
Depth = d".	8.00	8.06
Wt. per foot.	17.5	19.0
Area. Sq. In..	5.20	5.68
b"......	5.250	5.270
t.......	.250	.270
h.......	7.164	7.164
m......	.418	.448
n.......	.210	.240
f.......	.30	.30
c.......	6.625	6.625
g.......	2¼	2¼
u.......	11/32	⅜
AXES X-X I....	57.7	63.7
AXES X-X S....	14.43	15.81
AXES X-X r....	3.33	3.35
AXES Y-Y I....	6.39	7.20
AXES Y-Y S....	2.44	2.73
AXES Y-Y r....	1.11	1.13
Coef. Str....	173100	189700
Max.Mom."#	259700	284500
V.......	24000	26100
P. feet..	3.61	3.63
R.......	20600	22300
W......	22500	23900
Q. feet..	3.85	3.97
w. lbs...	13	13
Rivet dia....	¾	¾

Live Load deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	17.5 lb. Laterally fixed	17.5 lb. Laterally free	19.0 lb. Laterally fixed	19.0 lb. Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
2	48.0	48.0	52.2	52.2	
3	48.0	48.0	52.2	52.2	
4	43.3	43.3	47.4	47.4	.037
5	34.6	34.6	38.0	38.0	.058
6	28.9	28.9	31.6	31.6	.084
7	24.7	24.3	27.1	26.7	.114
8	21.6	20.6	23.7	22.6	.149
9	19.2	17.6	21.1	19.4	.189
10	17.3	15.2	19.0	16.8	.233
11	15.7	13.3	17.2	14.6	.281
12	14.4	11.6	15.8	12.8	.335
13	13.3	10.3	14.6	11.3	.394
14	12.4	9.1	13.6	10.0	.456
15	11.5	8.0	12.6	8.8	.524
16	10.8	7.2	11.9	8.0	.596
17	10.2	6.5	11.2	7.1	.674



BETHLEHEM BEAMS

9" B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration

V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	9.00	9.06	
Wt. per foot.	20.5	22.0	
Area. Sq. In..	6.09	6.51	
b"......	5.500	5.510	
t.......	.250	.260	
h.......	8.062	8.062	
m......	.469	499	
n.......	.250	.280	
f.......	.30	.30	
c.......	7.500	7.500	
g.......	2½	2½	
u.......	⅜	13/32	
AXES X-X I....	86.5	93.9	Live Load deflection must not exceed 1/360 of the Span.
AXES X-X S....	19.22	20.73	Live Load Def. = Total Def. × Live Load / Tabular Load
AXES X-X r....	3.77	3.80	
AXES Y-Y I....	8.54	9.42	
AXES Y-Y S....	3.10	3.42	
AXES Y-Y r....	1.18	1.20	
Coef. Str....	230700	248700	
Max. Mom."#	346000	373100	
V.......	27000	28300	
P. feet..	4.27	4.39	
R......	21300	22400	
W......	22500	23400	
Q. feet..	5.13	5.31	
w. lbs...	13	13	
Rivet dia....	¾	¾	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	54.0	54.0	56.6	56.6	
4	54.0	54.0	56.6	56.6	
5	46.1	46.1	49.7	49.7	.052
6	38.5	38.5	41.5	41.5	.074
7	33.0	32.8	35.5	35.4	.101
8	28.8	27.7	31.1	30.0	.132
9	25.6	23.9	27.6	25.7	.168
10	23.1	20.7	24.9	22.4	.207
11	21.0	18.1	22.6	19.5	.250
12	19.2	15.9	20.7	17.2	.298
13	17.7	14.0	19.1	15.2	.350
14	16.5	12.5	17.8	13.5	.406
15	15.4	11.1	16.6	12.0	.466
16	14.4	9.9	15.5	10.7	.530
17	13.6	9.0	14.6	9.6	.599
18	12.8	8.0	13.8	8.7	.670
19	12.1	...	13.1	...	.747

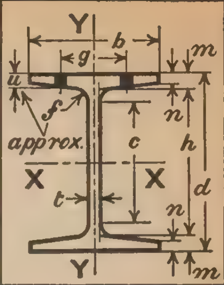
10" B

BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W. is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

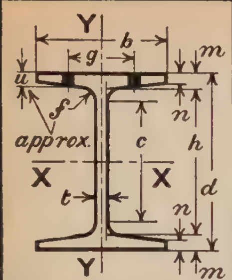
Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".	9.90	10.00	10.09	10.19	
Wt. per foot.	21.0	23.5	26.0	28.5	
Area. Sq. In..	6.28	6.96	7.68	8.41	
b".	5.740	5.750	5.770	5.785	
t.......	.240	.250	.270	.285	
h.......	8.972	8.972	8.972	8.972	
m......	.464	.514	.559	.609	
n.......	.235	.285	.330	.380	
f.......	.30	.30	.30	.30	
c.......	8.375	8.375	8.375	8.375	
g.......	2¾	2¾	2¾	2¾	
u.......	11/32	13/32	15/32	½	
AXES X-X I....	108.1	123.2	137.9	154.1	Live Load deflection must not exceed 1/360 of the Span.
AXES X-X S....	21.84	24.64	27.33	30.25	Live Load Def. = Total Def. × Live Load / Tabular Load
AXES X-X r....	4.15	4.21	4.24	4.28	
AXES Y-Y I....	9.30	10.9	12.5	14.2	
AXES Y-Y S....	3.24	3.80	4.33	4.92	
AXES Y-Y r....	1.22	1.25	1.28	1.30	
Coef. Str....	262100	295700	328000	362900	
Max.Mom."#	393100	443500	492000	544400	
V.......	28500	30000	32700	34800	
P. feet..	4.60	4.93	5.02	5.21	
R.......	20200	21300	23700	25400	
W......	21600	22500	23900	23900	
Q. feet..	6.07	6.57	6.86	7.59	
w. lbs...	13	13	13	13	
Rivet dia....	¾	¾	¾	¾	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	57.0	57.0	60.0	60.0	65.4	65.4	69.6	69.6	
4	57.0	57.0	60.0	60.0	65.4	65.4	69.6	69.6	
5	52.4	52.4	59.1	59.1	65.4	65.4	69.6	69.6	.047
6	43.7	43.7	49.3	49.3	54.7	54.7	60.5	60.5	.067
7	37.5	37.5	42.2	42.2	46.9	46.9	51.8	51.8	.091
8	32.8	32.0	37.0	36.1	41.0	40.0	45.4	44.3	.119
9	29.1	27.5	32.9	31.1	36.4	34.4	40.3	38.1	.151
10	26.2	23.9	29.6	27.0	32.8	30.0	36.3	33.2	.186
11	23.8	20.9	26.9	23.6	29.8	26.2	33.0	29.1	.225
12	21.9	18.5	24.6	20.8	27.3	23.1	30.2	25.6	.268
13	20.2	16.4	22.7	18.4	25.2	20.5	27.9	22.7	.315
14	18.7	14.5	21.1	16.4	23.4	18.3	25.9	20.2	.365
15	17.5	13.0	19.7	14.7	21.9	16.4	24.2	18.1	.419
16	16.4	11.7	18.5	13.2	20.5	14.7	22.7	16.3	.477
17	15.4	10.5	17.4	11.9	19.3	13.2	21.3	14.6	.539
18	14.6	9.5	16.4	10.7	18.2	11.9	20.2	13.2	.603
19	13.8	8.6	15.6	9.7	17.3	10.8	19.1	11.9	.672
20	13.1	...	14.8	...	16.4	...	18.2	...	.745
21	12.5	...	14.1	...	15.6	...	17.3	...	.821



BETHLEHEM BEAMS

12" B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	11.88	12.00	12.12	12.25	12.00	12.12	12.25
Wt. per foot.	25.0	28.0	31.5	36.0	40.0	44.0	48.5
Area. Sq. In. .	7.44	8.28	9.36	10.58	11.80	12.97	14.28
b"......	6.495	6.500	6.525	6.555	6.750	6.780	6.815
t.......	.240	.245	.270	.300	.330	.360	.395
h.......	10.900	10.900	10.900	10.900	10.530	10.530	10.530
m......	.490	.550	.610	.675	.735	.795	.860
n.......	.230	.290	.350	.415	.468	.528	.593
f.......	.35	.35	.35	.35	.40	.40	.40
c.......	10.250	10.250	10.250	10.250	9.750	9.750	9.750
g.......	3"	3"	3"	3"	3"	3"	3"
u.......	3/8	7/16	1/2	9/16	23/32	25/32	27/32
AXES X-X I....	185.1	213.6	245.7	281.8	301.2	335.1	373.2
AXES X-X S....	31.16	35.60	40.54	46.01	50.20	55.30	60.93
AXES X-X r....	4.99	5.08	5.12	5.16	5.05	5.08	5.11
AXES Y-Y I....	13.6	16.4	19.4	22.7	27.6	31.1	35.1
AXES Y-Y S....	4.19	5.04	5.93	6.93	8.18	9.18	10.29
AXES Y-Y r....	1.35	1.41	1.44	1.46	1.53	1.55	1.57
Coef. Str....	373900	427200	486500	552100	602400	663600	731200
Max. Mom. "#	560900	640800	729800	828100	903600	995300	1096700
V.......	34200	35300	39300	44100	47500	52400	58100
P. feet..	5.47	6.05	6.19	6.26	6.34	6.33	6.29
R.......	19900	20500	23800	27800	31700	35300	38900
W......	21600	22100	23860	23860	23860	23860	23860
Q. feet..	8.66	9.67	10.18	11.55	12.60	13.88	15.30
w. lbs...	13	13	13	13	13	13	13
Rivet dia....	3/4	3/4	3/4	3/4	3/4	3/4	3/4

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	68	68	71	71	79	79	88	88	95	95	105	105	116	116	
4	68	68	71	71	79	79	88	88	95	95	105	105	116	116	
5	68	68	71	71	79	79	88	88	95	95	105	105	116	116	
6	62	62	71	71	79	79	88	88	95	95	105	105	116	116	.056
7	53	53	61	61	70	70	79	79	86	86	95	95	104	104	.076
8	47	47	53	53	61	61	69	69	75	75	83	83	91	91	.099
9	42	41	47	46	54	53	61	60	67	66	74	73	81	80	.126
10	37	35	43	41	49	47	55	52	60	58	66	63	73	70	.155
11	34	31	39	36	44	41	50	46	55	51	60	56	66	62	.188
12	31	28	36	32	41	37	46	41	50	45	55	50	61	55	.223
13	29	25	33	28	37	32	42	36	46	40	51	45	56	49	.263
14	27	22	31	26	35	29	39	33	43	36	47	40	52	44	.304
15	25	20	28	22	32	26	37	30	40	33	44	36	49	40	.341
16	23	18	27	21	30	23	35	27	38	30	41	33	46	37	.398
17	22	16	25	19	29	22	32	24	35	27	39	30	43	33	.449
18	21	15	24	17	27	19	31	22	33	24	37	27	41	30	.503
19	20	14	22	15	26	18	29	20	32	23	35	25	38	27	.560
20	19	13	21	14	24	16	28	19	30	20	33	23	37	25	.621
21	18	11	20	13	23	15	26	17	29	19	32	21	35	23	.684
22	17	...	19	...	22	...	25	...	27	17	30	19	33	21	.751
23	16	...	19	...	21	...	24	...	26	...	29	...	32	...	.822
24	16	...	18	...	20	...	23	...	25	...	28	...	30	...	.894
25	15	...	17	...	19	...	22	...	24	...	27	...	29	...	.970

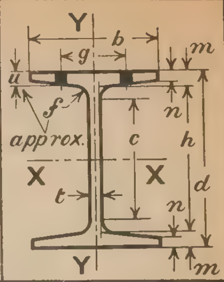
14" B

BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

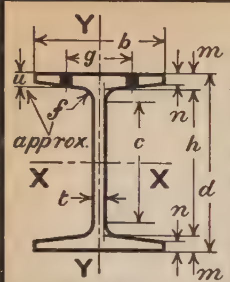
Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".		13.88	14.00	14.12	14.25	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.		30.0	33.0	37.5	42 0	
Area. Sq. In..		8.89	9 70	11.07	12.46	
b"......		6.750	6.750	6.790	6.825	
t.......		.265	.265	.305	.340	
h.......		12.824	12.824	12.824	12.824	
m.......		.528	.588	.648	.713	
n.......		.258	.318	.378	.443	
f.......		.40	.40	.40	.40	
c.......		12.125	12.125	12.125	12.125	
g.......		3½	3½	3½	3½	
u.......		13/32	15/32	½	19/32	
AXES X-X	I....	294.9	334.3	383.7	436.5	
	S....	42.49	47.76	54.35	61.26	
	r....	5.76	5.87	5.89	5.92	
AXES Y-Y	I....	16.9	19.9	23.4	27.3	
	S....	4.99	5.90	6.91	8.00	
	r....	1.38	1.43	1.46	1.48	
Coef. Str....		509900	573100	652200	735200	
Max. Mom."#		764900	859600	978300	1102700	
V.......		44100	44500	51700	58100	
P. feet..		5.78	6.44	6.31	6.33	
R......		22900	22800	28300	33100	
W......		23900	23900	27500	30600	
Q. feet..		10.67	11.99	11.86	12.01	
w. lbs...		19	19	19	19	
Rivet dia....		¾	¾	¾	¾	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
5	88.2	88.2	89.0	89 0	103	103	116	116	
6	85.0	85.0	89.0	89.0	103	103	116	116	
7	72.8	72.8	81.9	81.9	93.2	93.2	105	105	
8	63.7	63.7	71.6	71.6	81.5	81.5	91.9	91.9	
9	56.7	55.8	63.7	62.7	72 5	71.5	81.7	80.7	.108
10	51.0	49.0	57.3	55.0	65.2	62.7	73.5	70 7	133
11	46.4	43.3	52.1	48.6	59.3	55.4	66.8	62.5	.161
12	42.5	38.5	47.8	43.3	54.4	49.4	61.3	55.7	.192
13	39.2	34.4	44.1	38.7	50 2	44.1	56.6	49 9	.225
14	36.4	30.9	40.9	34.7	46.6	39 7	52.5	44.8	.261
15	34.0	27 9	38.2	31.3	43 5	35.8	49.0	40.4	.299
16	31 9	25.2	35 8	28.3	40.8	32.4	46.0	36.6	.341
17	30.0	22.9	33.7	25.7	38.4	29 4	43.2	33.2	.384
18	28.3	20.8	31.8	23.4	36.2	26.7	40.8	30.2	.431
19	26.8	19.0	30.2	21.4	34.3	24.4	38.7	27.6	.480
20	25.5	17.4	28.7	19.5	32 6	22 3	36 8	25.3	.532
21	24.3	15.9	27.3	17.9	31.1	20.5	35.0	23.1	.587
22	23.2	14.6	26.0	16.4	29.6	18.7	33.4	21.2	.644
23	22.2	....	24.9	....	28.4	....	32.0	....	.704
24	21.3	....	23.9	....	27.2	....	30.6	....	.766
25	20.4	....	22.9	....	26.1	....	29.4	....	.831
26	19.6	....	22.0	....	25.1	...	28.3	....	.899
27	18.9	....	21.2	....	24.2	....	27.2	....	.969
28	18.2	....	20.5	...	23.3	. . .	26.3	....	1.043
29	17.6	....	19.8	....	22.5	....	25.4	....	1.119
30	17.0	....	19.1	....	21.7	....	24 5	....	1.197



BETHLEHEM BEAMS

15" B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration

V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}''$ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	14.91	15.00	15.03	15.09	14.75	14.88	15.00	15.12	15.00
Wt. per foot.	36.0	38.5	40.0	42.5	46.0	50.5	54.5	59.5	71.5
Area. Sq. In.	10.61	11.37	11.80	12.50	13.63	14.84	16.05	17.49	21.04
b"	6.740	6.750	6.765	6.785	6.955	6.975	7.000	7.040	7.500
t	.280	.290	.305	.325	.365	.385	.410	.450	.520
h	13.662	13.662	13.662	13.662	13.250	13.250	13.250	13.250	12.848
m	.624	.669	.684	.714	.750	.815	.875	.935	1.076
n	.355	.400	.415	.445	.475	.540	.600	.660	.785
f	.40	.40	.40	.40	.50	.50	.50	.50	.60
c	12.875	12.875	12.875	12.875	12.375	12.375	12.375	12.375	11.750
g	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{3}{4}$
u	$\frac{1}{2}$	$\frac{17}{32}$	$\frac{9}{16}$	$\frac{19}{32}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{15}{16}$
AXES X-X I	410.9	447.6	463.3	492.0	508.2	563.3	617.0	676.2	799.5
AXES X-X S	55.12	59.68	61.65	65.21	68.91	75.71	82.27	89.44	106.60
AXES X-X r	6.22	6.27	6.27	6.27	6.11	6.16	6.20	6.22	6.16
AXES Y-Y I	21.7	24.1	25.1	26.9	30.8	34.7	38.6	42.8	60.9
AXES Y-Y S	6.45	7.15	7.42	7.93	8.85	9.96	11.0	12.2	16.2
AXES Y-Y r	1.43	1.46	1.46	1.47	1.50	1.53	1.55	1.56	1.70
Coef. Str.	661400	716200	739800	782500	826900	908500	987200	1073300	1279200
Max. Mom. "#	992100	1074200	1109700	1173700	1240300	1362800	1480800	1610000	1918800
V	50100	52200	55000	58900	64600	68700	73800	81700	93600
P. feet	6.60	6.86	6.73	6.64	6.40	6.61	6.69	6.57	6.83
R	24800	26200	28400	31300	37400	40100	43800	48900	56600
W	25200	26100	27500	29300	32900	34700	36900	40500	46800
Q. feet	13.12	13.72	13.45	13.35	12.57	13.09	13.38	13.25	13.67
w. lbs.	19	19	19	19	19	19	19	19	19
Rivet dia.	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$

Live Load deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
4	100	100	104	104	110	110	118	118	129	129	137	137	148	148	163	163	187	187	
5	100	100	104	104	110	110	118	118	129	129	137	137	148	148	163	163	187	187	
6	100	100	104	104	110	110	118	118	129	129	137	137	148	148	163	163	187	187	
7	94	94	102	102	106	106	112	112	118	118	130	130	141	141	153	153	183	183	.061
8	83	83	90	90	92	92	98	98	103	103	114	114	123	123	134	134	160	160	.079
9	73	72	80	79	82	81	87	86	92	91	101	100	110	109	119	118	142	142	.101
10	66	63	72	69	74	71	78	75	83	80	91	88	99	96	107	104	128	126	.124
11	60	56	65	61	67	63	71	66	75	71	83	78	90	85	98	93	116	112	.150
12	55	50	60	54	62	56	65	59	69	63	76	70	82	75	89	82	107	100	.179
13	51	45	55	48	57	50	60	53	64	57	70	62	76	68	83	74	98	90	.210
14	47	40	51	43	53	45	56	48	59	51	65	56	71	61	77	67	91	81	.243
15	44	36	48	39	49	40	52	43	55	46	61	51	66	55	72	60	85	73	.279
16	41	32	45	36	46	36	49	39	52	42	57	46	62	50	67	54	80	67	.318
17	39	30	42	32	43	33	46	35	49	38	53	41	58	45	63	49	75	61	.359
18	37	27	40	29	41	30	43	32	46	34	50	38	55	41	60	45	71	56	.402
19	35	25	38	27	39	28	41	29	44	32	48	35	52	38	56	41	67	51	.448
20	33	22	36	24	37	25	39	27	41	29	45	31	49	34	54	38	64	47	.497
21	32	21	34	22	35	23	37	24	39	26	43	29	47	32	51	35	61	43	.547
22	30	19	33	21	34	21	36	23	38	25	41	27	45	29	49	32	58	40	.601
23	29	...	31	...	32	...	34	...	36	22	39	24	43	27	47	30	56	37	.651
24	28	...	30	...	31	...	33	...	35	...	38	...	41	...	45	...	53	34	.715
25	27	...	29	...	30	...	31	...	33	...	36	...	40	...	43	...	51	31	.776
26	25	...	28	...	28	...	30	...	32	...	35	...	38	...	41	...	49	...	.839
27	25	...	27	...	27	...	29	...	31	...	34	...	37	...	40	...	47	...	.905
28	24	...	26	...	26	...	28	...	30	...	32	...	35	...	38	...	46	...	.973
29	23	...	25	...	25	...	27	...	29	...	31	...	34	...	37	...	44	...	1.040
30	22	...	24	...	25	...	26	...	28	...	30	...	33	...	36	...	43	...	1.120

LOADS BY A. I. S. C. SPECIFICATION

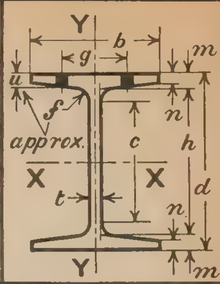
16" B

BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

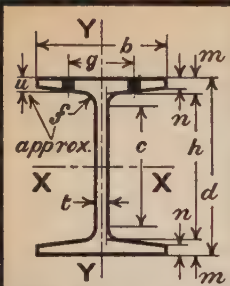
Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".	15.81	16.00	16.12	16.25	15.88	16.00	16.12	16.25	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.	35.0	40.0	45.0	50.0	56.5	60.5	66.0	71.5	
Area. Sq. In..	10.29	11.83	13.26	14 78	16.63	17.89	19.40	21.07	
b"	7.240	7.250	7.285	7.320	8.485	8.500	8.530	8.565	
t	.285	.295	.330	.365	.375	.390	.420	.455	
h	14.704	14.704	14.704	14.704	14.248	14.248	14.248	14.248	
m	.553	.648	.708	.773	.816	.876	.936	1.001	
n	.263	.358	.418	.483	.479	.539	.599	.664	
f	.40	.40	.40	.40	.50	.50	.50	.50	
c	14.000	14.000	14.000	14.000	13.375	13.375	13.375	13.375	
g	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	
u	13/32	1/2	9/16	5/8	11/16	3/4	13/16	7/8	
AXES X-X I	435.8	526.2	594.5	669.0	742.3	812.1	888.4	973.5	
AXES X-X S	55.13	65.78	73.76	82.34	93.49	101.51	110.22	119.82	
AXES X-X r	6.51	6.67	6.69	6.73	6.68	6.74	6.77	6.80	
AXES Y-Y I	21.4	27.6	31.9	36.6	57.8	64.3	71.2	79.0	
AXES Y-Y S	5.92	7.61	8.75	10.01	13.6	15.1	16.7	18.4	
AXES Y-Y r	1.44	1.53	1.55	1.57	1.86	1.90	1.92	1.94	
Coef. Str.	661500	789300	885100	988100	1121900	1218100	1322700	1437800	
Max. Mom. "#	992300	1184000	1327700	1482100	1682800	1827200	1984000	2156700	
V	54100	56600	63800	71200	71500	74900	81200	88700	
P. feet	6.11	6.97	6.94	6.94	7.85	8.13	8.14	8.11	
R	25400	26700	31900	37100	39000	41100	45500	50600	
W	25700	25700	28800	32400	33800	35100	37800	41000	
Q. feet	12.87	15.36	15.37	15.25	16.60	17.35	17.50	17.53	
w. lbs.	19	19	19	19	19	19	19	19	
Rivet dia.	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	108	108	113	113	128	128	142	142	143	143	150	150	162	162	177	177	
7	95	95	113	113	126	126	141	141	143	143	150	150	162	162	177	177	
8	83	83	99	99	111	111	124	124	140	140	150	150	162	162	177	177	
9	74	74	88	88	98	98	110	110	125	125	135	135	147	147	160	160	
10	66	65	79	77	89	87	99	97	112	112	122	122	132	132	144	144	.116
11	60	57	72	69	81	77	90	86	102	101	111	110	120	119	131	130	.141
12	55	51	66	61	74	69	82	76	94	91	102	99	110	107	120	117	.168
13	51	46	61	55	68	61	76	69	86	82	94	89	102	97	111	106	.197
14	47	41	56	49	63	55	71	62	80	74	87	81	95	88	103	96	.228
15	44	37	53	45	59	50	66	56	75	68	81	74	88	80	96	87	.262
16	41	34	49	40	55	45	62	51	70	62	76	67	83	74	90	80	.298
17	39	31	46	37	52	42	58	46	66	57	72	62	78	67	85	74	.336
18	37	28	44	34	49	38	55	43	62	52	68	57	74	62	80	67	.377
19	35	26	42	31	47	35	52	39	59	48	64	52	70	57	76	62	.420
20	33	24	40	29	44	32	49	35	56	44	61	48	66	53	72	57	.466
21	32	22	38	26	42	29	47	33	53	41	58	45	63	49	69	54	.513
22	30	20	36	24	40	27	45	30	51	38	55	41	60	45	65	49	.563
23	29	19	34	22	39	25	43	28	49	36	53	39	58	42	63	46	.616
24	28	17	33	21	37	23	41	26	47	33	51	36	55	39	60	43	.670
25	27	...	32	...	35	...	40	...	45	31	49	34	53	36	58	40	.727
26	25	...	30	...	34	...	38	...	43	29	47	31	51	34	55	37	.787
27	25	...	29	...	33	...	37	...	42	27	45	29	49	32	53	34	.848
28	24	...	28	...	32	...	35	...	40	25	44	27	47	29	51	32	.912
29	23	...	27	...	31	...	34	...	39	...	42	...	46	...	50	...	.979
30	22	...	26	...	30	...	33	...	37	...	41	...	44	...	48	...	1.047



BETHLEHEM BEAMS

18" B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

	Depth = d".	17.94	18.00	18.06	18.12	17.75	17.88	18.00	18.12
	Wt. per foot.	47.0	49.0	52.0	54.5	59.0	64.5	69.0	74.0
	Area. Sq. In..	13.90	14.44	15.34	16.06	17.48	18.97	20.38	21.79
	b"......	7.495	7.500	7.525	7.540	8.710	8.730	8.750	8.770
	t.......	.325	.330	.355	.370	.380	.400	.420	.440
	h.......	16.532	16,532	16.532	16.532	16.136	16.136	16.136	16.136
	m......	.704	.734	.764	.794	.807	.872	.932	.992
	n.......	.405	.435	.465	.495	.460	.525	.585	.645
	f.......	.40	.40	.40	.40	.50	.50	.50	.50
	c.......	15.750	15.750	15.750	15.750	15.250	15.250	15.250	15.250
	g.......	3¾	3¾	3¾	3¾	4"	4"	4"	4"
	u.......	9/16	19/32	5/8	21/32	21/32	23/32	25/32	27/32
AXES X-X	I....	764.1	802.8	851.7	896.1	960.3	1059.7	1153.7	1249.2
	S....	85.18	89.20	94.32	98.91	108.20	118.53	128.19	137.88
	r....	7.42	7.46	7.45	7.47	7.41	7.47	7.53	7.57
AXES Y-Y	I....	34.0	36.1	38.7	41.1	60.7	68.4	75.6	82.9
	S....	9.06	9.64	10.3	10.9	13.9	15.7	17.3	18.9
	r....	1.56	1.58	1.59	1.60	1.86	1.90	1.93	1.95
	Coef. Str....	1022200	1070400	1131800	1186900	1298400	1422400	1538300	1654600
	Max. Mom."#	1533300	1605600	1697700	1780300	1947600	2133600	2307400	2481800
	V.......	70000	71300	76900	80500	80900	85800	90700	95700
	P. feet..	7.30	7.51	7.36	7.37	8.02	8.29	8.48	8.64
	R.......	31000	31800	35800	38200	40200	43100	46300	49500
	W......	36600	37100	39900	41600	42800	45000	47300	49500
	Q. feet..	13.96	14.43	14.18	14.27	15.17	15.80	16.26	16.71
	w. lbs...	25	25	25	25	25	25	25	25
	Rivet dia....	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least.
For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	140	140	143	143	154	154	161	161	162	162	172	172	181	181	191	191	
7	140	140	143	143	154	154	161	161	162	162	172	172	181	181	191	191	
8	128	128	134	134	141	141	148	148	162	162	172	172	181	181	191	191	
9	114	114	119	119	126	126	132	132	144	144	158	158	171	171	184	184	.084
10	102	100	107	105	113	111	119	117	130	130	142	142	154	154	165	165	.103
11	93	89	97	93	103	99	108	104	118	118	129	129	140	140	150	150	.125
12	85	80	89	83	94	88	99	93	108	106	119	116	128	125	138	135	.149
13	79	72	82	75	87	80	91	83	100	96	109	104	118	113	127	122	.175
14	73	65	76	68	81	72	85	76	93	87	102	96	110	103	118	111	.203
15	68	59	71	61	75	65	79	68	87	80	95	87	103	94	110	101	.233
16	64	54	67	56	71	60	74	62	81	72	89	80	96	86	103	92	.265
17	60	49	63	51	67	54	70	57	76	66	84	73	90	79	97	85	.299
18	57	45	59	46	63	50	66	52	72	61	79	67	85	72	92	78	.335
19	54	41	56	43	60	46	62	47	68	56	75	62	81	67	87	72	.373
20	51	37	54	40	57	42	59	44	65	52	71	57	77	62	83	67	.414
21	49	35	51	36	54	38	57	41	62	47	68	53	73	57	79	62	.456
22	47	32	49	34	51	35	54	37	59	45	65	50	70	53	75	57	.501
23	44	29	47	31	49	33	52	35	56	41	62	46	67	50	72	53	.548
24	43	28	45	29	47	30	49	31	54	39	59	42	64	46	69	50	.596
25	41	...	43	27	45	28	47	29	52	36	57	40	62	43	66	46	.647
26	39	...	41	...	44	..	46	...	50	34	55	37	59	40	64	44	.699
27	38	...	40	...	42	...	44	...	48	32	53	35	57	38	61	40	.754
28	37	...	38	...	40	...	42	...	46	29	51	33	55	35	59	38	.811
29	35	...	37	...	39	...	41	...	45	28	49	30	53	33	57	35	.870
30	34	...	36	...	38	...	40	...	43	...	47	...	51	...	55	...	.931
31	33	...	35	...	37	...	38	...	42	...	46	...	50	...	53	...	.994
32	32	...	33	...	35	...	37	...	41	...	44	...	48	...	52	...	1.06
33	31	...	32	...	34	...	36	...	39	...	43	...	47	...	50	...	1.13
34	30	...	31	...	33	...	35	...	38	...	42	...	45	...	49	..	1.20
35	29	...	31	...	32	...	34	...	37	...	41	...	44	...	47	...	1.27

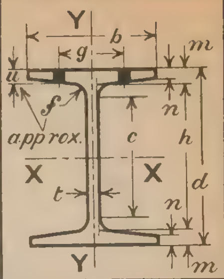
20" B

BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets.

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



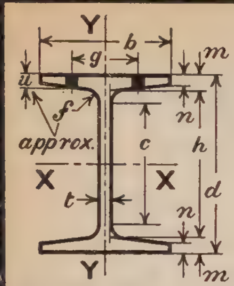
Depth = d".	19.88	20.00	20.06	20.12	19.88	20.00	20.09
Wt. per foot.	56.0	59.5	62.0	64.5	68.5	73.0	78.0
Area. Sq In.	16.51	17.47	18.25	18.93	20.12	21.58	22.98
b"	8.000	8.000	8.015	8.025	8.855	8.875	8.905
t	.375	.375	.390	.400	.410	.430	.460
h	18.392	18.392	18.392	18.392	18.136	18.136	18.136
m	.744	.804	.834	.864	.872	.932	.977
n	.425	.485	.515	.545	.520	.580	.625
f	.45	.45	.45	.45	.55	.55	.55
c	17.625	17.625	17.625	17.625	17.125	17.125	17.125
g	4"	4"	4"	4"	4"	4"	4"
u	19/32	21/32	11/16	23/32	23/32	25/32	27/32
AXES X-X I	1086.1	1181.5	1239.8	1295.1	1366.0	1485.0	1585.5
AXES X-X S	109.27	118.15	123.61	128.74	137.42	148.50	157.84
AXES X-X r	8.11	8.22	8.24	8.27	8.24	8.30	8.31
AXES Y-Y I	43.5	48.6	51.5	54.3	71.0	78.5	84.7
AXES Y-Y S	10.9	12.2	12.9	13.5	16.0	17.7	19.0
AXES Y-Y r	1.62	1.67	1.68	1.69	1.88	1.91	1.92
Coef. Str.	1311200	1417800	1483300	1544800	1649100	1782000	1894100
Max. Mom. "#	1966800	2126700	2225000	2317300	2473600	2673000	2841100
V.	89500	90000	93900	96600	97800	103200	110900
P. feet	7.33	7.88	7.90	8.00	8.43	8.63	8.54
R.	39100	38900	41500	43200	45100	48400	53500
W.	42200	42200	43900	45000	46200	48400	51800
Q. feet	15.54	16.80	16.89	17.17	17.85	18.41	18.28
w. lbs.	25	25	25	25	25	25	25
Rivet dia.	7/8	7/8	7/8	7/8	7/8	7/8	7/8

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	179	179	180	180	188	188	193	193	196	196	206	206	222	222	
8	164	164	177	177	185	185	193	193	196	196	206	206	222	222	
10	131	131	142	142	148	148	154	154	165	165	178	178	189	189	.093
11	119	116	129	126	135	132	140	137	150	150	162	162	172	172	.113
12	109	104	118	113	124	119	129	124	137	134	149	146	158	155	.134
13	101	94	109	102	114	106	119	111	127	122	137	132	146	141	.158
14	94	86	101	92	106	97	110	100	118	111	127	120	135	127	.183
15	87	77	95	84	99	88	103	91	110	101	119	110	126	116	.210
16	82	71	89	77	93	80	97	84	103	93	111	100	118	106	.239
17	77	65	83	70	87	73	91	76	97	85	105	92	111	98	.270
18	73	59	79	64	82	67	86	70	92	79	99	85	105	90	.302
19	69	55	75	59	78	62	81	64	87	73	94	79	100	84	.336
20	66	51	71	54	74	57	77	59	83	67	89	72	95	78	.373
21	62	46	68	50	71	53	74	55	79	62	85	67	90	71	.411
22	60	43	64	46	67	48	70	50	75	58	81	62	86	66	.451
23	57	40	62	43	64	45	67	47	72	54	77	58	82	62	.493
24	55	37	59	40	62	42	64	43	69	50	74	54	79	58	.537
25	52	34	57	37	59	39	62	41	66	47	71	50	76	54	.582
26	50	32	55	35	57	36	59	37	63	43	69	47	73	50	.630
27	49	...	53	...	55	...	57	...	61	41	66	44	70	47	.679
28	47	...	51	...	53	...	55	...	59	38	64	41	68	44	.736
29	45	...	49	...	51	...	53	...	57	36	61	38	65	41	.783
30	44	...	47	...	49	...	51	...	55	...	59	...	63	...	.838
31	42	...	46	...	48	...	50	...	53	...	57	...	61	...	.895
32	41	...	44	...	46	...	48	...	52	...	56	...	59	...	.954
33	40	...	43	...	45	...	47	...	50	...	54	...	57	...	1.01
34	39	...	42	...	44	...	45	...	49	...	52	...	56	...	1.08
35	38	...	41	...	42	...	44	...	47	...	51	...	54	...	1.14
36	36	...	39	...	41	...	43	...	46	...	50	...	53	...	1.21
37	35	...	38	...	40	...	42	...	45	...	48	...	51	...	1.28



BETHLEHEM BEAMS

22″ B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½″ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d″.		21.88	22.00	22.12	22.25	21.88	22.00	22.12	22.25
Wt. per foot.		58.0	62.5	67.5	73.0	77.0	83.0	89.0	96.5
Area. Sq. In..		17.14	18.38	19.84	21.51	22.74	24.51	26.28	28.38
b″......		8.490	8.500	8.520	8.545	9.220	9.250	9.280	9.320
t.......		.360	.370	.390	.415	.425	.455	.485	.525
h.......		20.424	20.424	20.424	20.424	20.010	20.010	20.010	20.010
m......		.728	.788	.848	.913	.935	.995	1.055	1.120
n.......		.390	.450	.510	.575	.569	.629	.689	.754
f.......		.50	.50	.50	.50	.55	.55	.55	.55
c.......		19.500	19.500	19.500	19.500	19.000	19.000	19 000	19.000
g.......		4″	4″	4″	4″	4″	4″	4″	4″
u.......		9/16	5/8	11/16	3/4	25/32	27/32	29/32	31/32
AXES X-X	I....	1363.9	1495.4	1637.5	1796.7	1866.7	2026.5	2188.6	2373.7
	S....	124.67	135.95	148.06	161.50	170.63	184.23	197.88	213.37
	r....	8.92	9.02	9.08	9.14	9.06	9.09	9.13	9.15
AXES Y-Y	I....	48.9	55.2	61.8	69.1	87.0	95.8	104.8	115.1
	S....	11.5	13.0	14.5	16.2	18.9	20.7	22.6	24.7
	r....	1.69	1.73	1.76	1.79	1.96	1.98	2.00	2.01
Coef. Str....		1496000	1631300	1776700	1938000	2047600	2210700	2374600	2560400
Max.Mom."#		2244100	2447000	2665000	2907000	3071300	3316100	3561900	3840600
V.......		94500	97700	103500	110800	111600	120100	128700	140200
P. feet..		7.92	8 35	8 58	8.75	9.17	9 20	9 23	9.13
R......		36000	37700	41300	45800	47700	53000	58400	65400
W......		48600	49980	52680	56060	57400	61400	65500	70900
Q. feet..		15.39	16.32	16.86	17 29	17.84	18.00	18.13	18.06
w. lbs...		30	30	30	30	30	30	30	30
Rivet dia....		7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	189	189	195	195	207	207	222	222	223	223	240	240	257	257	280	280	
8	187	187	195	195	207	207	222	222	223	223	240	240	257	257	280	280	
10	150	150	163	163	178	178	194	194	205	205	221	221	237	237	256	256	.085
12	125	121	136	132	148	144	162	158	171	169	184	182	198	196	213	211	.122
14	107	99	117	109	127	118	138	128	146	139	158	151	170	162	183	175	.166
16	94	83	102	90	111	98	121	107	128	117	138	126	148	135	160	147	.217
18	83	70	91	76	99	83	108	91	114	99	123	107	132	115	142	124	.274
20	75	60	82	65	89	71	97	77	102	85	111	92	119	99	128	107	.339
21	71	55	78	60	85	66	92	71	98	79	105	85	113	92	122	99	.373
22	68	51	74	55	81	61	88	66	93	73	101	80	108	86	116	92	.410
23	65	47	71	52	77	56	84	61	89	68	96	74	103	79	111	86	.448
24	62	44	68	48	74	52	81	57	85	64	92	69	99	74	107	80	.488
25	60	41	65	44	71	49	78	54	82	60	88	64	95	69	102	75	.529
26	58	39	63	42	68	45	75	50	79	56	85	60	91	65	99	70	.572
27	55	35	60	39	66	43	72	47	76	52	82	56	88	61	95	66	.617
28	53	33	58	36	63	39	69	43	73	49	79	53	85	57	91	61	.664
29	52	...	56	...	61	...	67	...	71	46	76	49	82	53	88	58	.712
30	50	...	54	...	59	...	65	...	68	43	74	47	79	50	85	54	.762
31	48	...	53	...	57	...	63	...	66	...	71	...	77	...	83	51	.813
32	47	...	51	...	56	...	61	...	64	..	69	...	74	...	80	...	.867
33	45	...	49	...	54	...	59	...	62	...	67	...	72	...	78	...	.927
34	44	...	48	...	52	...	57	...	60	...	65	...	70	...	75	...	.979
35	43	...	47	...	51	...	55	...	59	...	63	...	68	...	73	...	1.04
36	42		45	...	49	...	54	...	57	...	61	...	66	...	71	...	1.10
38	39	...	43	...	47	...	51	...	54	...	58	...	63	...	67	...	1.22
40	37	...	41	...	44	...	48	...	51	...	55	...	59	...	64	...	1.35
42	36	...	39	...	42	...	46	...	49	...	53	...	57	...	61	...	1.49
44	34	...	37	...	40	...	44	...	...	...	...	...	...	...	...	...	1.64
46	33	...	35	...	39	...	42	...	...	...	...	...	...	...	..	...	1.7[illegible]

LOADS BY A. I. S. C. SPECIFICATION

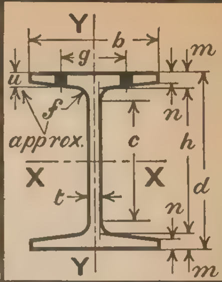
24" B

BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia   S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



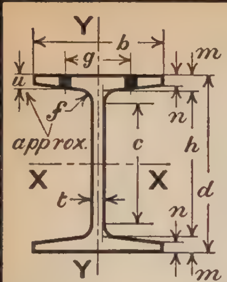
Depth = d".	23.88	24.00	24.09	24.00	24.12	23.91	24.00	24.09
Wt. per foot.	70.0	73.5	79.5	84.5	90.5	95.5	99.5	104.5
Area. Sq. In..	20.62	21.70	23.35	24.97	26.47	28.05	29.40	30.88
b"......	9.000	9.000	9.035	9.500	9.515	9.730	9.750	9.775
t.......	.395	.395	.430	.460	.475	.505	.525	.550
h.......	22.242	22.242	22.242	22.106	22.106	21.822	21.822	21.822
m.......	.819	.879	.924	.947	1.007	1.044	1.089	1.134
n.......	.460	.520	.565	.570	.630	.660	.705	.750
f.......	.50	.50	.50	.55	.55	.60	.60	.60
c.......	21.375	21.375	21.375	21.125	21.125	20.750	20.750	20.750
g.......	4"	4"	4"	4"	4"	5½	5½	5½
u.......	21/32	23/32	25/32	13/16	27/32	13/16	7/8	29/32
AXES X-X I....	1954.1	2108.8	2266.7	2405.7	2588.2	2692.7	2841.3	2997.3
AXES X-X S....	163.66	175.73	188.19	200.48	214.61	225.24	236.78	248.84
AXES X-X r....	9.74	9.86	9.85	9.82	9.89	9.80	9.83	9.85
AXES Y-Y I....	67.4	74.7	81.2	95.8	104.9	117.1	124.9	132.9
AXES Y-Y S....	15.0	16.6	18.0	20.2	22.1	24.1	25.6	27.2
AXES Y-Y r....	1.81	1.86	1.87	1.96	1.99	2.04	2.06	2.07
Coef. Str....	1963900	2108800	2258200	2405700	2575300	2702800	2841300	2986100
Max. Mom."#	2945900	3163200	3387300	3608600	3863000	4054200	4262000	4479100
V.......	113200	113800	124300	132500	137500	144900	151200	159000
P. feet..	8.67	9.27	9.08	9.08	9.36	9.33	9.40	9.39
R.......	42000	41800	48400	54100	56800	62700	66600	71400
W......	53300	53300	58100	62100	64100	68200	70900	71600
Q. feet..	18.42	19.78	19.43	19.37	20.09	19.82	20.04	20.85
w. lbs...	30	30	30	30	30	30	30	30
Rivet dia....	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	226	226	228	228	249	249	265	265	275	275	290	290	302	302	318	318	
8	226	226	228	228	249	249	265	265	275	275	290	290	302	302	318	318	
10	196	196	211	211	226	226	241	241	258	258	270	270	284	284	299	299	.078
12	164	162	176	173	188	185	201	200	215	214	225	225	237	237	249	249	.112
14	140	132	151	143	161	152	172	165	184	177	193	187	203	197	213	206	.152
16	123	111	132	120	141	128	150	138	161	149	169	157	178	166	187	174	.199
18	109	94	117	101	125	108	134	118	143	126	150	134	158	141	166	148	.251
20	98	80	105	86	113	93	120	101	129	109	135	115	142	121	149	127	.310
21	94	75	100	80	108	86	114	94	123	101	129	107	135	113	142	118	.342
22	89	69	96	75	103	80	109	87	117	94	123	100	129	105	136	111	.375
23	85	64	92	69	98	74	105	82	112	88	117	93	124	98	130	103	.411
24	82	60	88	65	94	69	100	76	107	82	113	87	118	91	124	96	.447
25	79	56	84	60	90	64	96	71	103	76	108	81	114	86	119	90	.485
26	76	53	81	56	87	61	93	67	99	72	104	76	109	80	115	85	.525
27	73	49	78	53	84	57	89	63	95	67	100	71	105	75	111	80	.566
28	70	46	75	49	81	53	86	59	92	63	97	68	101	70	107	75	.608
29	68	43	73	46	78	50	83	55	89	59	93	63	98	67	103	70	.653
30	66	41	70	43	75	47	80	52	86	56	90	59	95	63	100	66	.698
31	63	...	68	...	73	...	78	49	83	52	87	56	92	59	96	62	.746
32	61	...	66	...	71	...	75	...	81	...	84	52	89	56	93	58	.795
33	60	...	64	...	68	...	73	...	78	...	82	...	86	...	90	...	.845
34	58	...	62	...	66	...	71	...	76	...	79	...	84	...	88	...	.897
35	56	...	60	...	65	...	69	...	74	...	77	...	81	...	85	...	.950
36	55	...	59	...	63	...	67	...	72	...	75	...	79	...	83	...	1.01
38	52	...	55	...	59	...	63	...	68	...	71	...	75	...	79	...	1.12
40	49	...	53	...	56	...	60	...	64	...	68	...	71	...	75	...	1.24
42	47	...	50	...	54	...	57	...	61	...	64	...	68	...	71	...	1.37
44	45	...	48	...	51	...	55	...	59	...	61	...	65	...	68	...	1.50
46	43	...	46	...	49	...	52	...	56	...	59	...	62	...	65	...	1.64
48	41	...	44	...	47	...	50	...	54	...	56	...	59	...	62	...	1.79



BETHLEHEM BEAMS

26" B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	25.78	25.88	26.00	26 12	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.	81.0	85.5	91.0	98.0	
Area.Sq. In..	23.90	25.11	26.76	28.69	
b"......	9 470	9.480	9.500	9.530	
t.......	.440	450	.470	.500	
h.......	24.036	24.036	24.036	24.036	
m......	.872	.922	.982	1.042	
n.......	.495	.545	.605	.665	
f.......	.55	.55	.55	.55	
c.......	23.00	23.00	23.00	23.00	
g.......	5½	5½	5½	5½	
u.......	21/32	11/16	¾	13/16	
AXES X-X I....	2600.1	2772.5	2993 1	3231.2	
AXES X-X S....	201.71	214.26	230.24	247.41	
AXES X-X r....	10.43	10.51	10.58	10 61	
AXES Y-Y I....	84.3	91 7	100.9	110.6	
AXES Y-Y S....	17.8	19.3	21.2	23.2	
AXES Y-Y r....	1.88	1.91	1.94	1.96	
Coef. Str....	2420600	2571100	2762900	2968900	
Max.Mom."#	3630900	3856600	4144300	4453400	
V.......	136100	139700	146600	156800	
P. feet..	8.89	9.20	9.42	9.47	
R.......	50400	52100	56000	62100	
W......	69300	70900	74000	78800	
Q. feet..	17.46	18 13	18 67	18.84	
w. lbs...	35	35	35	35	
Rivet dia....	1"	1"	1"	1"	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	81.0 Laterally fixed	81.0 Laterally free	85.5 Laterally fixed	85.5 Laterally free	91.0 Laterally fixed	91.0 Laterally free	98.0 Laterally fixed	98.0 Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
10	242	242	257	257	276	276	297	297	072
12	202	201	214	213	230	229	247	246	.103
14	173	166	184	177	197	189	212	204	.140
16	151	139	161	148	173	160	186	172	.183
18	135	119	143	126	153	135	165	146	.232
20	121	102	129	109	138	116	148	125	.287
21	115	94	122	100	132	109	141	116	.316
22	110	88	117	94	126	101	135	108	.347
23	105	82	112	87	120	94	129	101	.379
24	101	77	107	81	115	88	124	95	.413
25	97	72	103	76	110	82	119	88	.448
26	93	67	99	71	106	77	114	83	.484
27	90	63	95	67	102	72	110	77	.522
28	87	59	92	63	99	68	106	73	.562
29	84	56	89	59	95	63	102	68	.602
30	81	52	86	55	92	59	99	64	.645
31	78	49	83	52	89	56	96	61	.688
32	76	...	80	...	86	...	93	...	.733
33	73	...	78	...	84	...	90	...	.780
34	71	...	76	...	81	...	87	...	.832
35	69	...	74	...	79	...	85	...	.877
36	67	...	72	...	77	...	82	...	.928
38	64	...	68	...	73	...	78	...	1.03
40	61	...	64	...	69	...	74	...	1.15
42	58	...	61	...	66	...	71	...	1.26
44	55	...	58	...	63	...	67	...	1.39
46	53	...	56	...	60	...	65	...	1.52
48	50	...	54	...	58	...	62	...	1.65
50	48	...	51	...	55	...	59	...	1.79

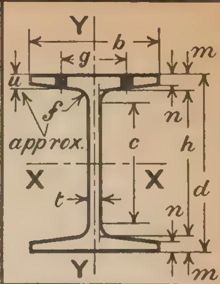
28" B

BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



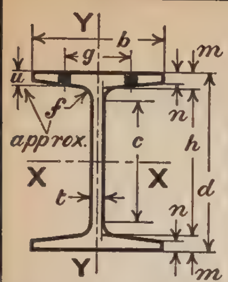
Depth = d".	27.88	28 00	28.12	28 25
Wt. per foot.	91.0	97.0	104.0	112.0
Area. Sq. In..	26.86	28 61	30.66	32 95
b"......	9.980	10.000	10.030	10 065
t.......	.450	.470	.500	.535
h.......	26 008	26.008	26.008	26.008
m......	.936	.996	1.056	1.121
n.......	.539	.599	.659	.724
f.......	.60	.60	.60	.60
c......	24 875	24.875	24.875	24.875
g.......	5½.	5½	5½	5½
u......	23/32	25/32	27/32	29/32
AXES X-X I....	3441.1	3711.5	4003.3	4328.0
AXES X-X S....	246.85	265.11	284.73	306 41
AXES X-X r....	11.32	11.39	11.43	11.46
AXES Y-Y I....	106.7	117.4	128.7	141.2
AXES Y-Y S....	21.4	23.5	25.7	28.1
AXES Y-Y r....	1.99	2.03	2.05	2.07
Coef. Str....	2962200	3181300	3416700	3676900
Max.Mom."#	4443300	4771900	5125100	5515300
V.	150600	157900	168700	181400
P. feet	9.83	10.07	10.13	10.13
R......	51700	55900	62100	69500
W....	81000	84600	90000	95400
Q. feet..	18 29	18 80	18.98	19.27
w. lbs...	40	40	40	40
Rivet dia....	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
10	296	296	316	316	337	337	363	363	.066
12	247	247	265	265	285	285	306	306	.096
14	212	206	227	221	244	238	263	256	.123
16	185	174	199	187	214	201	230	216	.170
18	165	149	177	159	190	171	204	184	.215
20	148	128	159	137	171	148	184	159	.266
21	141	119	151	127	163	138	175	148	.293
22	135	111	145	119	155	128	167	138	.322
23	129	104	138	111	149	120	160	129	.352
24	123	96	133	104	142	112	153	121	.383
25	118	90	127	97	137	105	147	113	.416
26	114	85	122	91	131	98	141	106	.450
27	110	80	118	86	127	93	136	100	.485
28	106	75	114	81	122	87	131	93	.521
29	102	70	110	76	118	82	127	88	.559
30	99	67	106	71	114	77	123	83	.599
31	96	63	103	68	110	72	119	78	.639
32	93	59	99	63	107	69	115	74	.681
33	90	56	96	60	104	65	111	70	.724
34	87	...	94	...	100	...	108	...	.769
35	85	...	91	...	98	...	105	...	.815
36	82	...	88	...	95	...	102	...	.862
38	78	...	84	...	90	...	97	...	.960
40	74	...	80	...	85	...	92	...	1.06
42	71	...	76	...	81	...	88	...	1.17
44	67	...	72	...	78	...	84	...	1.29
46	64	...	69	...	74	...	80	...	1.40
48	62	...	66	...	71	...	77	...	1.53
50	59	...	64	...	68	...	74	...	1.66



BETHLEHEM BEAMS

30" B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	29.78	29.88	30.00	30.12	
Wt. per foot.	110.0	115.0	121.0	129.0	
Area. Sq. In..	32.45	33.80	35.65	37.82	
b"......	10.470	10.480	10.500	10.530	
t.......	.520	.530	.550	.580	
h.......	27.690	27.690	27.690	27.690	
m......	1.045	1.095	1.155	1.215	
n.......	.630	.680	.740	.800	
f.......	.65	.65	.65	.65	
c.......	26 50	26.50	26.50	26.50	
g.......	5½	5½	5½	5½	
u.......	27/32	7/8	15/16	1"	
AXES X-X I....	4687.7	4942.9	5269.7	5622.7	Live Load deflection must not exceed 1/360 of the Span.
AXES X-X S....	314.82	330.85	351.31	373.35	Live Load Def. = Total Def. × Live Load / Tabular Load
AXES X-X r....	12.02	12.09	12.16	12.19	
AXES Y-Y I....	141.8	151.8	164.3	177.6	
AXES Y-Y S....	27.1	29.0	31.3	33.7	
AXES Y-Y r....	2.09	2.12	2.15	2.17	
Coef. Str....	3777900	3970200	4215800	4480200	
Max. Mom. "#	5666800	5955300	6323600	6720400	
V.......	185800	190000	198000	209700	
P. feet..	10.17	10.45	10.65	10.68	
R......	66600	68400	72800	79400	
W......	105300	107400	107400	107400	
Q. feet..	17.94	18.48	19.63	20.86	
w. lbs...	45	45	45	45	
Rivet dia....	1"	1"	1"	1"	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
12	315	315	331	331	351	351	373	373	.089
14	270	266	284	280	301	296	320	315	.122
16	236	225	248	236	263	250	280	267	.159
18	210	192	221	203	234	214	249	229	.201
20	189	166	198	174	211	186	224	198	.248
21	180	155	189	163	201	173	213	184	.274
22	172	145	180	152	192	162	204	172	.300
23	164	135	173	143	183	151	195	161	.329
24	157	127	165	133	176	142	187	151	.358
25	151	119	159	125	169	133	179	141	.388
26	145	112	153	118	162	125	172	133	.420
27	140	105	147	111	156	117	166	125	.452
28	135	99	142	104	151	111	160	118	.487
29	130	93	137	98	145	104	154	111	.522
30	126	88	132	92	141	99	149	104	.559
31	122	83	128	87	136	93	144	99	.596
32	118	78	124	83	132	88	140	93	.636
33	115	75	120	78	128	83	136	89	.676
34	111	70	117	74	124	78	132	84	.718
35	108	...	113	...	120	74	128	79	.760
36	105	...	110	...	117	...	124	...	.804
38	99	...	104	...	111	...	118	...	.896
40	95	...	99	...	105	...	112	...	.993
42	90	...	95	...	100	...	107	...	1.10
44	86	...	90	...	96	...	102	...	1.20
46	82	...	86	...	92	...	97	...	1.31
48	79	...	83	...	88	...	93	...	1.43
50	76	...	79	...	84	...	90	...	1.55
52	73	...	76	...	81	...	86	...	1.68
54	70	...	74	...	78	...	83	...	1.81

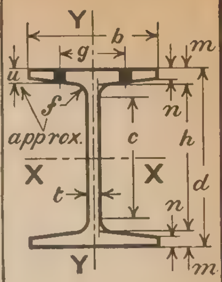
33″ B

BETHLEHEM BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½″ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



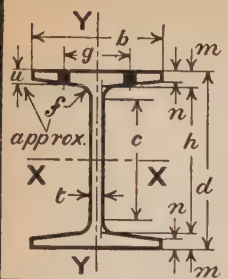
Depth = d″.	32.88	33.00	33.12	33.25	
Wt. per foot.	125.0	135.0	143.0	152.0	
Area. Sq. In. .	36.88	39.55	42.05	44.69	
b″.	11.210	11.250	11.285	11.320	
t.	.540	.580	.615	.650	
h.	30.676	30 676	30 676	30.676	
m.	1.102	1.162	1.222	1.287	
n.	.658	.718	.778	.843	
f.	.70	.70	.70	.70	
c.	29.375	29.375	29.375	29.375	
g.	7½	7½	7½	7½	
u.	13/16	7/8	15/16	1″	
AXES X-X I. . . .	6482.7	6967.4	7442.2	7953.4	
AXES X-X S. . . .	394.32	422.27	449.41	478.40	
AXES X-X r. . . .	13.26	13.27	13.30	13.34	
AXES Y-Y I. . . .	182.3	198.7	215.1	233.0	
AXES Y-Y S. . . .	32.5	35.3	38.1	41.2	
AXES Y-Y r. . . .	2.22	2.24	2.26	2.28	
Coef. Str. . . .	4731900	5067200	5392900	5740800	
Max. Mom. ″#	7097800	7600800	8089300	8611200	
V.	213100	229700	244400	259400	
P. feet. .	11.10	11.03	11.03	11.07	
R.	70400	79700	87900	96200	
W.	107370	107370	107370	107370	
Q. feet. .	22.04	23.60	25.11	26.73	
w. lbs. . .	45	45	45	45	
Rivet dia. . . .	1″	1″	1″	1″	

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
12	394		422		449		478		.081
14	338		362		385		410		.111
16	296	287	317	307	337	327	359	349	.144
18	263	247	282	265	300	282	319	300	.183
20	237	214	253	229	270	245	287	260	.226
21	225	200	241	214	257	229	273	243	.249
22	215	187	230	200	245	214	261	228	.273
23	206	176	220	188	235	201	250	214	.298
24	197	165	211	177	225	189	239	201	.325
25	189	155	203	166	216	177	230	189	.353
26	182	146	195	157	207	166	221	178	.381
27	175	137	188	148	200	157	213	168	.411
28	169	130	181	139	193	149	205	158	.442
29	163	122	175	132	186	140	198	149	.475
30	158	116	169	124	180	133	191	141	.508
31	153	110	164	118	174	125	185	133	.542
32	148	104	158	111	169	119	179	126	.578
33	143	98	154	106	163	112	174	120	.614
34	139	93	149	100	159	107	169	114	.652
35	135	88	145	95	154	101	164	108	.691
36	131	84	141	90	150	96	160	103	.731
38	125		133		142		151		.815
40	118		127		135		144		.903
42	113		121		128		137		.995
44	108		115		123		131		1.09
46	103		110		117		125		1.19
48	99		106		112		120		1.30
50	95		101		108		115		1.41
52	91		97		104		110		1.53
54	88		94		100		106		1.65



BETHLEHEM BEAMS

36" B

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}$" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	35.88	36.00	36.12	36.25	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × $\frac{\text{Live Load}}{\text{Tabular Load}}$
Wt. per foot.	147.0	155.0	164.0	173.0	
Area. Sq. In..	43.24	45.58	48.10	50.94	
b"......	11.975	12.000	12.030	12.065	
t.......	.590	.615	.645	.680	
h.......	33.502	33.502	33.502	33.502	
m......	1.189	1.249	1.309	1.374	
n.......	.715	.775	.835	.900	
f.......	.75	.75	.75	.75	
c.......	32.125	32.125	32.125	32.125	
g.......	$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	
u.......	$\frac{29}{32}$	$\frac{31}{32}$	$1\frac{1}{32}$	$1\frac{3}{32}$	
AXES X-X I....	8986.2	9547.4	10133.	10784	
AXES X-X S....	500.90	530.41	561.07	594.98	
AXES X-X r....	14.42	14.47	14.51	14.55	
AXES Y-Y I....	240.9	259.9	279.4	301.1	
AXES Y-Y S....	40.2	43.3	46.5	49.9	
AXES Y-Y r....	2.36	2.39	2.41	2.43	
Coef. Str....	6010800	6364900	6732900	7139800	
Max. Mom."#	9016300	9547400	10099300	10709600	
V.......	254000	265700	279600	295800	
P. feet..	11.83	11.98	12.04	12.07	
R.......	81900	88100	95500	104300	
W......	107370	107370	107370	107370	
Q. feet..	27.99	29.64	31.35	33.25	
w. lbs...	45	45	45	45	
Rivet dia ...	1"	1"	1"	1"	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
12	501		530		559		592		.074
14	429		455		481		510		.101
16	376	370	398	392	421	415	446	440	.132
18	334	319	354	333	374	358	397	380	.167
20	301	279	318	294	337	312	357	331	.207
21	286	260	303	276	321	293	340	310	.228
22	273	244	289	258	306	274	325	291	.250
23	261	229	277	243	293	258	310	273	.273
24	250	216	265	229	281	243	297	257	.298
25	240	203	255	216	269	228	286	243	.323
26	231	192	245	203	259	216	275	229	.350
27	223	182	236	192	249	203	264	215	.377
28	215	172	227	181	240	192	255	204	.406
29	207	162	219	171	232	182	246	193	.435
30	200	153	212	162	224	172	238	183	.466
31	194	146	205	154	217	163	230	173	.497
32	188	138	199	146	210	155	223	164	.530
33	182	131	193	139	204	147	216	156	.563
34	177	125	187	132	198	140	210	148	.598
35	172	118	182	125	192	133	204	141	.634
36	167	113	177	119	187	126	198	134	.670
38	158	102	167	108	177	115	188	122	.747
40	150		159		168	104	178	110	.828
42	143		152		160		170		.912
44	137		145		153		162		1.001
46	131		138		146		155		1.094
48	125		133		140		149		1.191
50	120		127		135		143		1.293
52	116		122		129		137		1.399
54	111		118		125		132		1.508

ALLOWABLE END REACTIONS FOR BETHLEHEM BEAMS

DETERMINED BY

BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight per foot	Web t	Unit Stress in Buckling	Reaction R for 3½" Bearing	Min. Span for 3½" Bearing	Reaction R for 5½" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V	Length of Bearing to develop V
8	17.5	.250"	15000	20600	4.19'	24000	3750	24000	4.40"
	19.0	.270	15000	22300	4.25	26100	4050	26100	4.44
9	20.5	.250	14800	21300	5.41	27000	3700	27000	5.05
	22.0	.260	15000	22400	5.54	28300	3900	28300	5.01
10	21.0	.240	14030	20200	6.49	27000	3370	28500	5.96
	23.5	.250	14210	21300	6.93	28400	3550	30000	5.94
	26.0	.270	14660	23700	6.91	31700	3960	32700	5.76
	28.5	.285	14840	25400	7.15	33800	4230	34800	5.73
12	25.0	.240	12780	19900	9.39	26000	3070	34200	8.17
	28.0	.245	12860	20500	10.42	26800	3150	35300	8.21
	31.5	.270	13470	23800	10.22	31000	3640	39300	7.77
	36.0	.300	14090	27800	9.93	36200	4230	44100	7.36
	40.0	.330	14750	31700	9.50	41400	4870	47500	6.75
	44.0	.360	15000	35300	9.40	46100	5400	52400	6.67
	48.5	.395	15000	38900	9.40	50800	5930	58100	6.74
14	30.0	.265	12350	22900	11.13	29400	3270	44100	9.99
	33.0	.265	12290	22800	12.57	29300	3260	44500	10.15
	37.5	.305	13260	28300	11.52	36400	4040	51700	9.30
	42.0	.340	13920	33100	11.10	42600	4730	58100	8.78
15	36.0	.280	12220	24800	13.34	31600	3420	50100	10.90
	38.5	.290	12460	26200	13.67	33400	3610	52200	10.70
	40.0	.305	12830	28400	13.01	36200	3910	55000	10.30
	42.5	.325	13290	31300	12.50	40000	4320	58900	9.89
	46.0	.365	14150	37400	11.06	47700	5160	64600	8.77
	50.5	.385	14360	40100	11.33	51200	5530	68700	8.67
	54.5	.410	14720	43800	11.27	55800	6040	73800	8.48
	59.5	.450	15000	48900	10.97	62400	6750	81700	8.35
	71.5	.520	15000	56600	11.30	72200	7800	93600	8.25
16	35.0	.285	11900	25400	13.02	32200	3390	54100	11.96
	40.0	.295	12080	26700	14.78	33800	3560	56600	11.90
	45.0	.330	12880	31900	13.87	40400	4250	63800	11.01
	50.0	.365	13530	37100	13.32	46900	4940	71200	10.41
	56.5	.375	13860	39000	14.38	49400	5200	71500	9.75
	60.5	.390	14060	41100	14.82	52100	5480	74900	9.67
	66.0	.420	14450	45500	14.53	57700	6070	81200	9.38
	71.5	.455	14840	50600	14.21	64100	6750	88700	9.14
18	47.0	.325	11940	31000	16.49	38800	3880	70000	13.54
	49.0	.330	12030	31800	16.83	39700	3970	71300	13.46
	52.0	.355	12600	35800	15.80	44700	4470	76900	12.69
	54.5	.370	12910	38200	15.53	47800	4780	80500	12.35
	59.0	.380	13200	40200	16.15	50200	5020	80900	11.62
	64.5	.400	13460	43100	16.50	53900	5390	85800	11.43
	69.0	.420	13780	46300	16.61	57900	5790	90700	11.19
	74.0	.440	14080	49500	16.63	61900	6190	95700	10.95

The beam web is treated as a column with fixed ends, having an effective length L of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.

When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

ALLOWABLE END REACTIONS FOR BETHLEHEM BEAMS
DETERMINED BY
BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

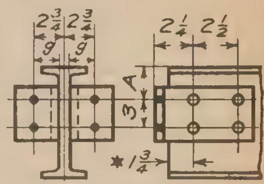
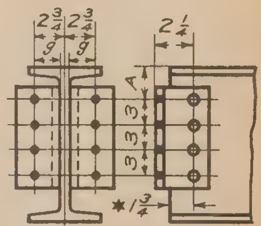
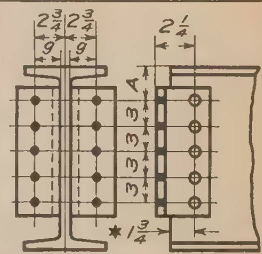
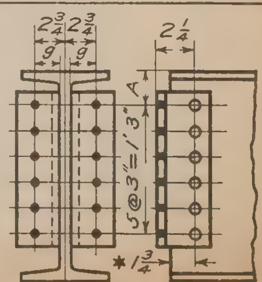
Depth in Inches	Weight per foot	Web t	Unit Stress in Buckling	Reaction R for 3½″ Bearing	Min. Span for 3½″ Bearing	Reaction R for 5½″ Bearing	Increase in R for 1″ Additional Bearing	Max. Web Shear V	Length of Bearing to develop V
20	56.0	.375″	12260	39100	16.77′	48300	4600	89500	14.46″
	59.5	.375	12210	38900	18.23	48100	4580	90000	14.66
	62.0	.390	12520	41500	17.87	51300	4880	93900	14.23
	64.5	.400	12710	43200	17.88	53400	5080	96600	14.00
	68.5	.410	12930	45100	18.28	55700	5300	97800	13.45
	73.0	.430	13230	48400	18.41	59700	5690	103200	13.14
	78.0	.460	13690	53500	17.70	66100	6300	110900	12.61
22	58.0	.360	11140	36000	20.78	44000	4010	94500	18.10
	62.5	.370	11330	37700	21.64	46100	4190	97700	17.82
	67.5	.390	11720	41300	21.51	50400	4570	103500	17.12
	73.0	.415	12170	45800	21.16	55900	5050	110800	16.38
	77.0	.425	12480	47700	21.46	58300	5300	111600	15.56
	83.0	.455	12950	53000	20.86	64800	5890	120100	14.89
	89.0	.485	13370	58400	20.33	71300	6480	128700	14.36
	96.5	.525	13850	65400	19.58	80000	7270	140200	13.78
24	70.0	.395	11190	42000	23.38	50800	4420	113200	19.61
	73.5	.395	11150	41800	25.22	50600	4400	113800	19.85
	79.5	.430	11850	48400	23.33	58600	5090	124300	18.40
	84.5	.460	12380	54100	22.24	65500	5700	132500	17.26
	90.5	.475	12590	56800	22.67	68800	5980	137500	16.99
	95.5	.505	13080	62700	21.55	73000	6600	144900	15.94
	99.5	.525	13350	66600	21.33	80600	7010	151200	15.57
	104.5	.550	13660	71400	20.91	86400	7510	159000	15.16
26	81.0	.440	11450	50400	24.01	60500	5040	136100	20.50
	85.5	.450	11570	52100	24.68	62500	5210	139700	20.33
	91.0	.470	11920	56000	24.66	67200	5600	146600	19.66
	98.0	.500	12410	62100	23.90	74500	6210	156800	18.77
28	91.0	.450	10980	51700	28.65	61600	4940	150600	23.52
	97.0	.470	11310	55900	28.46	66500	5320	157900	22.68
	104.0	.500	11790	62100	27.51	73900	5900	168700	21.56
	112.0	.535	12290	69500	26.45	82700	6580	181400	20.51
30	110.0	.520	11640	66600	28.36	78700	6050	185800	23.21
	115.0	.530	11740	68400	29.02	80900	6220	190000	23.05
	121.0	.550	12040	72800	28.95	86000	6620	198000	22.41
	129.0	.580	12450	79400	28.21	93900	7220	209700	21.54
33	125.0	.540	11130	70400	33.61	82500	6010	213100	27.24
	135.0	.580	11690	79700	31.79	93200	6780	229700	25.63
	143.0	.615	12130	87900	30.68	102800	7460	244400	24.48
	152.0	.650	12530	96200	29.84	112400	8140	259400	23.55
36	147.0	.590	11140	81900	36.70	95100	6570	254000	29.69
	155.0	.615	11460	88100	36.12	102200	7050	265700	28.69
	164.0	.645	11820	95500	35.25	110700	7620	279600	27.66
	173.0	.680	12210	104300	34.23	120900	8300	295800	26.58

The beam web is treated as a column with fixed ends, having an effective length L of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.

When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

CONNECTION ANGLES FOR BETHLEHEM BEAMS

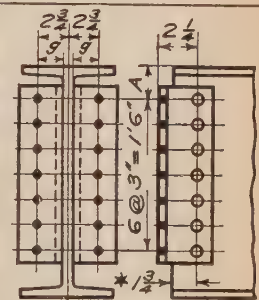
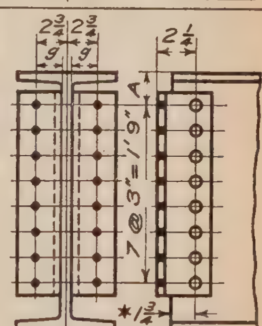
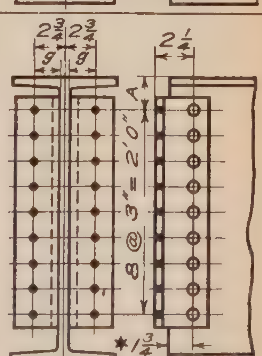
DIMENSIONS, WEIGHTS, AND WORKING LOADS — **¾" POWER DRIVEN RIVETS**

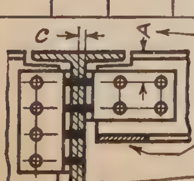
Beam Depth	Beam Weight per foot	Connection Value Web	Connection Value Outstanding Single Shear Power Driven Rivets	Connection Value Outstanding Single Shear Unfinished Bolts	Framing Distance C	Connection Angles A.I.S.C. Mark	Connection Angles Gage g	Connection Angles Size and Length	Connection Angles Weight inc. Web Rivets	Connection Details.
8"	17.5	22500	23860	17670	3/16	IC.13.10	2 5/8	6" × 4" × 3/8" 0' — 5½" Long	13 lbs.	
	19.0	24300	23860	17670	3/16	IC.13.10	2 5/8			
9"	20.5	22500	23860	17670	3/16	IC.13.10	2 5/8			
	22.0	23400	23860	17670	3/16	IC.13.10	2 5/8			
10"	21.0	21600	23860	17670	3/16	IC.13.10	2 5/8			
	23.5	22500	23860	17670	3/16	IC.13.10	2 5/8			
	26.0	24300	23860	17670	3/16	IC.13.10	2 5/8			
	28.5	24460	23860	17670	3/16	IC.13.10	2 5/8			
12"	25.0	21600	23860	17670	3/16	IC.13.10	2 5/8			
	28.0	22050	23860	17670	3/16	IC.13.10	2 5/8			
	31.5	24300	23860	17670	3/16	IC.13.10	2 5/8			
	36.0	27000	23860	17670	3/16	IC.13.10	2 5/8			
	40.0	29700	23860	17670	1/4	IC.13. 9	2 9/16			
	44.0	32400	23860	17670	1/4	IC.13. 9	2 9/16			
	48.5	35570	23860	17670	1/4	IC.13. 9	2 9/16			
14"	30.0	23850	47720	35340	3/16	IC.19.10	2 5/8	4" × 3½" × 3/8" 0' — 11½" Long	19 lbs.	
	33.0	23850	47720	35340	3/16	IC.19.10	2 5/8			
	37.5	27450	47720	35340	3/16	IC.19.10	2 5/8			
	42.0	30600	47720	35340	1/4	IC.19. 9	2 9/16			
15"	36.0	25200	47720	35340	3/16	IC.19.10	2 5/8			
	38.5	26100	47720	35340	3/16	IC.19.10	2 5/8			
	40.0	27450	47720	35340	1/4	IC.19.10	2 5/8			
	42.5	29250	47720	35340	1/4	IC.19. 9	2 9/16			
	46.0	32850	47720	35340	1/4	IC.19. 9	2 9/16			
	50.5	34650	47720	35340	1/4	IC.19. 9	2 9/16			
	54.5	36900	47720	35340	1/4	IC.19. 9	2 9/16			
	59.5	40500	47720	35340	5/16	IC.19. 8	2 ½			
	71.5	46800	47720	35340	5/16	IC.19. 8	2 ½			
16"	35.0	25650	47720	35340	3/16	IC.19.10	2 5/8			
	40.0	25650	47720	35340	3/16	IC.19.10	2 5/8			
	45.0	28800	47720	35340	1/4	IC.19. 9	2 9/16			
	50.0	32400	47720	35340	1/4	IC.19. 9	2 9/16			
	56.5	33750	47720	35340	1/4	IC.19. 9	2 9/16			
	60.5	35100	47720	35340	1/4	IC.19. 9	2 9/16			
	66.0	37800	47720	35340	1/4	IC.19. 9	2 9/16			
	71.5	40960	47720	35340	5/16	IC.19. 8	2 ½			
18"	47.0	36580	59650	44180	1/4	IC.25. 9	2 9/16	4" × 3½" × 3/8" 1' — 2½" Long	25 lbs.	
	49.0	37130	59650	44180	1/4	IC.25. 9	2 9/16			
	52.0	39940	59650	44180	1/4	IC.25. 9	2 9/16			
	54.5	41630	59650	44180	1/4	IC.25. 9	2 9/16			
	59.0	42750	59650	44180	1/4	IC.25. 9	2 9/16			
	64.5	45000	59650	44180	1/4	IC.25. 9	2 9/16			
	69.0	47250	59650	44180	1/4	IC.25. 9	2 9/16			
	74.0	49500	59650	44180	5/16	IC.25. 8	2 ½			
20"	56.0	42200	59650	44180	1/4	IC.25. 9	2 9/16			
	59.5	42200	59650	44180	1/4	IC.25. 9	2 9/16			
	62.0	43880	59650	44180	1/4	IC.25. 9	2 9/16			
	64.5	45000	59650	44180	1/4	IC.25. 9	2 9/16			
	68.5	46150	59650	44180	1/4	IC.25. 9	2 9/16			
	73.0	48380	59650	44180	1/4	IC.25. 9	2 9/16			
	78.0	51750	59650	44180	5/16	IC.25. 8	2 ½			
22"	58.0	48600	71580	53020	1/4	IC.30. 9	2 9/16	4" × 3½" × 3/8" 1' — 5½" Long	30 lbs.	
	62.5	49980	71580	53020	1/4	IC.30. 9	2 9/16			
	67.5	52680	71580	53020	1/4	IC.30. 9	2 9/16			
	73.0	56060	71580	53020	1/4	IC.30. 9	2 9/16			
	77.0	57390	71580	53020	1/4	IC.30. 9	2 9/16			
	83.0	61440	71580	53020	5/16	IC.30. 8	2 ½			
	89.0	65490	71580	53020	5/16	IC.30. 8	2 ½			
	96.5	70890	71580	53020	5/16	IC.30. 8	2 ½			
24"	70.0	53330	71580	53020	1/4	IC.30. 9	2 9/16			
	73.5	53330	71580	53020	1/4	IC.30. 9	2 9/16			
	79.5	58050	71580	52020	5/16	IC.30. 9	2 9/16			
	84.5	62100	71580	53020	5/16	IC.30. 8	2 ½			
	90.5	64140	71580	53020	5/16	IC.30. 8	2 ½			
	95.5	68180	71580	53020	5/16	IC.30. 8	2 ½			
	99.5	70880	71580	53020	5/16	IC.30. 8	2 ½			
	104.5	71580	71580	53020	5/16	IC.30. 8	2 ½			

LOADS BY A. I. S. C. SPECIFICATION

CONNECTION ANGLES FOR BETHLEHEM BEAMS

DIMENSIONS, WEIGHTS AND WORKING LOADS — **¾" POWER DRIVEN RIVETS**

Beam		Connection Value			Framing Distance	Connection Angles				Connection Details.
Depth	Weight per foot	Web	Outstanding Single Shear Power Driven Rivets	Outstanding Single Shear Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	
26"	81.0	69300	83510	61850	5/16	IC.35. 8	2 ½	4" × 3½" × 3/8" 1' — 8½" Long	35 lbs.	
	85.5	70875	83510	61850	5/16	IC.35. 8	2 ½			
	91.0	74030	83510	61850	5/16	IC.35. 8	2 ½			
	98.0	78750	83510	61850	5/16	IC.35. 8	2 ½			
28"	91.0	81040	95440	70690	5/16	IC.40. 8	2 ½	4" × 3½" × 3/8" 1' — 11½" Long	40 lbs.	
	97.0	84640	95440	70690	5/16	IC.40. 8	2 ½			
	104.0	90000	95440	70690	5/16	IC.40. 8	2 ½			
	112.0	95440	95440	70690	5/16	IC.40. 8	2 ½			
30"	110.0	105300	107370	79530	5/16	IC.45. 8	2 ½	4" × 3½" × 3/8" 2' — 2½" Long	45 lbs.	
	115.0	107370	107370	79530	5/16	IC.45. 8	2 ½			
	121.0	107370	107370	79530	5/16	IC.45. 8	2 ½			
	129.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			
33"	125.0	107370	107370	79530	5/16	IC.45. 8	2 ½			
	135.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			
	143.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			
	152.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			
36"	147.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			
	155.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			
	164.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			
	173.0	107370	107370	79530	3/8	IC.45. 7	2 7/16			



When A = 2¾" all beams up to and including 26" can be framed opposite with tops flush.

When A = 3" all beams except 14" can be framed opposite with tops flush.

Flange must be cut away as shown for field riveting on all beams framing opposite a larger beam, if flange interferes with outstanding rivets.

Minimum Web required to develop Single Shearing Value is .33"
Minimum Web required to develop Double Shearing Value is .53"

LOADS BY A. I. S. C. SPECIFICATION

NOTES and DIAGRAMS

Part IV

Section 6

Bethlehem Girder Beams

Dimensions

Technical Functions

Allowable Total Loads
by
A. I. S. C. Specification

Allowable End Reactions

Standard Connection Angles

Usual Stock Sizes	
Depth	**Weight**
8″	33.0 #
9	38.5
10	44.5
12	55.5
15	74.0
16	81.0
18	86.0
20	113.0
22	108.0
24	120.0
26	151.0
28	165.0
30	180.0
33	210.0
36	240.0

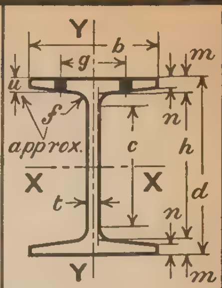
8" G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S. is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



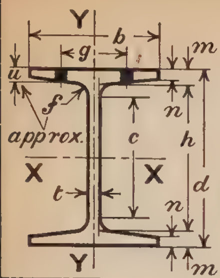
Depth = d".	7.88	8.00	8.12
Wt. per foot.	29.5	33.0	36.5
Area. Sq. In. .	8.69	9.69	10.81
b"......	7.995	8.000	8.020
t.......	.285	.290	.310
h.......	6.738	6.738	6.738
m......	.571	.631	.691
n.......	.250	.310	.370
f.......	.40	.40	.40
c.......	5.938	5.938	5.938
g.......	5½	5½	5½
u.......	11/32	13/32	15/32
AXES X-X I....	100.7	116.1	132.6
AXES X-X S....	25.56	29.03	32.66
AXES X-X r....	3.41	3.46	3.50
AXES Y-Y I....	28.4	33.6	39.0
AXES Y-Y S....	7.10	8.39	9.72
AXES Y-Y r....	1.81	1.86	1.90
Coef. Str....	306700	348300	391900
Max. Mom."#	460000	522500	587900
V.......	26900	27800	30200
P. feet..	5.70	6.27	6.49
R......	23400	23900	25700
W......	25650	26100	27920
Q. feet..	5.98	6.67	7.02
w. lbs...	16	16	16
Rivet dia....	⅞	⅞	⅞

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
5	54	54	56	56	60	60	
6	51	51	56	56	60	60	.084
7	44	44	50	50	56	56	.114
8	38	38	44	44	49	49	.149
9	34	34	39	39	44	44	.189
10	31	31	35	35	39	39	.233
11	28	27	32	31	36	35	.281
12	26	25	29	28	33	32	.335
13	24	22	27	25	30	28	.394
14	22	20	25	23	28	26	.456
15	20	18	23	20	26	23	.524
16	19	16	22	19	24	21	.596
17	18	15	20	17	23	19	.674
18	17	14	19	15	22	18	.754
19	16	13	18	14	21	16	.840
20	15	11	17	13	20	15	.931



BETHLEHEM GIRDER BEAMS

9" G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	8.94	9.00	9.12	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.	36.0	38.5	43.5	
Area. Sq. In..	10.66	11.35	12.73	
b"......	8.480	8.500	8.540	
t.......	.290	.310	.350	
h.......	7.628	7.628	7.628	
m......	.656	.686	.746	
n.......	.315	.345	.405	
f.......	.40	.40	.40	
c.......	6.875	6.875	6.875	
g.......	5½	5½	5½	
u.......	15/32	15/32	9/16	
AXES X-X I....	160.5	171.9	195.4	
AXES X-X S....	35.91	38.20	42.85	
AXES X-X r....	3.88	3.89	3.92	
AXES Y-Y I....	41.0	44.4	51.3	
AXES Y-Y S....	9.67	10.4	12.0	
AXES Y-Y r....	1.96	1.98	2.01	
Coef. Str....	430900	458400	514200	Total Deflection in inches for Maximum Load; Laterally fixed beam.
Max. Mom."*	646300	687600	771300	
V.......	31100	33500	38300	
P. feet..	6.93	6.84	6.71	
R.......	25000	26700	30200	
W......	26100	27900	31500	
Q. feet..	8.26	8.22	8.16	
w. lbs...	16	16	16	
Rivet dia....	⅞	⅞	⅞	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection
5	62	62	67	67	77	77	
6	62	62	67	67	77	77	
7	62	62	66	66	74	74	.101
8	54	54	57	57	64	64	.132
9	48	48	51	51	57	57	.168
10	43	43	46	46	51	51	.207
11	39	39	42	42	47	47	.250
12	36	35	38	37	43	42	.298
13	33	31	35	33	40	38	.350
14	31	29	33	31	37	34	.406
15	29	26	31	28	34	31	.466
16	27	24	29	26	32	28	530
17	25	22	27	23	30	26	.599
18	24	20	25	21	29	24	.670
19	23	19	24	20	27	22	747
20	22	17	23	18	26	21	.828

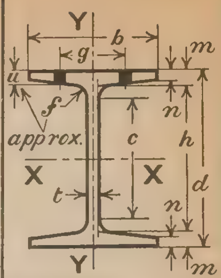
10" G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



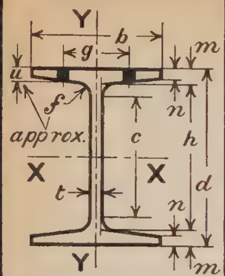
Depth = d".	9.91	10.00	10.12
Wt. per foot.	41.5	44.5	50.0
Area. Sq. In. .	12.23	13.14	14.62
b"......	8.990	9.000	9.040
t.......	.310	.320	.360
h.......	8.506	8.506	8.506
m......	.702	.747	.807
n.......	.340	385	.445
f.......	.40	.40	.40
c.......	7.750	7.750	7.750
g.......	5½	5½	5½
u.......	½	9/16	⅝
AXES X-X I....	225.8	246.7	277.5
AXES X-X S....	45.57	49.34	54.84
AXES X-X r....	4.30	4.33	4.36
AXES Y-Y I....	52.6	58.2	66.4
AXES Y-Y S....	11.7	12.9	14.7
AXES Y-Y r....	2.07	2.10	2.13
Coef. Str....	546800	592100	658100
Max. Mom."#	820300	888100	987100
V... ...	36900	38400	43700
P. feet..	7.41	7.71	7.53
R......	27900	28800	32400
W......	27900	28800	32400
Q. feet..	9.80	10.28	10.16
w. lbs...	16	16	16
Rivet dia....	⅞	⅞	⅞

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	74	74	77	77	87	87	
7	74	74	77	77	87	87	
8	68	68	74	74	82	82	.119
9	61	61	66	66	73	73	.151
10	55	55	59	59	66	66	.186
11	50	50	54	54	60	60	.225
12	46	45	49	48	55	54	.268
13	42	41	46	44	51	49	.315
14	39	37	42	40	47	45	.365
15	36	33	39	36	44	41	.419
16	34	31	37	34	41	37	.477
17	32	28	35	31	39	35	.539
18	30	26	33	28	37	32	.603
19	29	24	31	26	35	30	.672
20	27	22	30	25	33	27	.745
21	26	21	28	22	31	25	.821
22	25	19	27	21	30	23	.901
23	24	18	26	20	29	22	.986



BETHLEHEM GIRDER BEAMS

12″ G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}''$ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d″.	11.91	12.00	12.12	11.88	12.00	12.12	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$
Wt. per foot.	51.5	55.5	61.0	66.0	70.5	76.5	
Area. Sq. In..	15.21	16.35	17.92	19.32	20.79	22.50	
b″......	9.980	10.000	10.030	10.230	10.250	10.290	
t.......	.360	.380	.410	.450	.470	.510	
h.......	10.388	10.388	10.388	10.066	10.066	10.066	
m......	.761	.806	.866	.907	.967	1.027	
n.......	.360	.405	.465	.500	.560	.620	
f.......	.45	.45	.45	.55	.55	.55	
c.......	9.5	9.5	9.5	9.0	9.0	9.0	
g.......	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	
u.......	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{23}{32}$	$\frac{25}{32}$	$\frac{13}{16}$	
AXES X-X I....	400.6	435.6	483.6	496.9	543.6	594.2	
AXES X-X S....	67.27	72.60	79.80	83.65	90.60	98.05	
AXES X-X r....	5.13	5.16	5.20	5.07	5.11	5.14	
AXES Y-Y I....	76.9	84.9	95.9	108.3	119.7	132.1	
AXES Y-Y S....	15.4	17.0	19.1	21.2	23.4	25.7	
AXES Y-Y r....	2.25	2.28	2.31	2.37	2.40	2.42	
Coef. Str....	807300	871200	957600	1003800	1087200	1176600	
Max. Mom. ″#	1210900	1306800	1436400	1505800	1630800	1764900	
V....	51500	54700	59700	64100	67700	74200	
P. feet..	7.84	7.96	8.02	7.83	8.03	7.93	
R......	35100	37100	40000	43900	45800	49700	
W.....	48600	51300	55350	60750	63450	68850	
Q. feet..	8.31	8.49	8.65	8.26	8.57	8.54	
w. lbs...	24	24	24	24	24	24	
Rivet dia....	1″	1″	1″	1″	1″	1″	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	103	103	109	109	119	119	128	128	135	135	148	148	
7	103	103	109	109	119	119	128	128	135	135	148	148	
8	101	101	109	109	119	119	126	126	135	135	147	147	
9	90	90	97	97	106	106	112	112	121	121	131	131	.126
10	81	81	87	87	96	96	100	100	109	109	118	118	155
11	73	73	79	79	87	87	91	91	99	99	107	107	188
12	67	67	73	73	80	80	84	84	91	91	98	98	223
13	62	61	67	66	74	73	77	77	84	84	91	91	.263
14	58	56	62	60	68	66	72	71	78	76	84	82	304
15	54	52	58	55	64	61	67	64	72	69	78	75	341
16	50	47	54	51	60	56	63	59	68	64	74	70	398
17	48	44	51	47	56	52	59	55	64	59	69	64	449
18	45	41	48	43	53	48	56	51	60	55	65	59	503
19	43	38	46	41	50	44	53	47	57	51	62	55	560
20	40	35	44	38	48	41	50	44	54	47	59	52	621
21	38	32	41	35	46	39	48	41	52	44	56	48	684
22	37	30	40	33	44	36	46	38	49	41	54	45	751
23	35	28	38	31	42	34	44	36	47	38	51	42	.822
24	34	27	36	28	40	31	42	33	45	36	49	39	.894
25	32	24	35	27	38	29	40	31	43	33	47	37	970

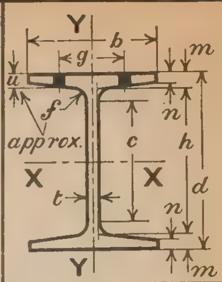
15″ G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½″ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

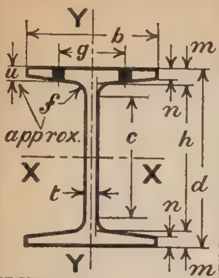
Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d″.	14.82	14.88	15.00	15.12	14.80	14.88	15.00	15.12	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.	64.5	69.0	74.0	80.5	94.0	99.0	105.0	111.0	
Area. Sq. In..	19.09	20.18	21.76	23.66	27.66	29.00	30.80	32.75	
b″......	10.700	10.730	10.750	10.790	11.190	11.220	11.250	11.290	
t.......	.390	.420	.440	.480	.540	.570	.600	.640	
h.......	13.120	13.120	13.120	13.120	12.542	12.542	12.542	12.542	
m......	.850	.880	.940	1.000	1.129	1.169	1.229	1.289	
n.......	.420	.450	.510	.570	.685	.725	.785	.845	
f.......	.55	.55	.55	.55	.70	.70	.70	.70	
c.......	12.125	12.125	12.125	12.125	11.250	11.250	11.250	11.250	
g.......	7½	7½	7½	7½	7½	7½	7½	7½	
u.......	9/16	19/32	21/32	23/32	27/32	7/8	15/16	1″	
AXES X-X I....	771.6	815.3	892.7	977.4	1090.2	1147.7	1231.3	1319.3	
AXES X-X S....	104.13	109.58	119.03	129.29	147.32	154.26	164.17	174.51	
AXES X-X r....	6.36	6.36	6.40	6.43	6.28	6.29	6.32	6.35	
AXES Y-Y I....	108.6	115.8	128.9	143.1	187.4	198.5	214.4	231.3	
AXES Y-Y S....	20.3	21.6	24.0	26.5	33.5	35.4	38.1	41.0	
AXES Y-Y r....	2.39	2.40	2.43	2.46	2.60	2.62	2.64	2.66	
Coef. Str....	1249500	1315000	1428300	1551400	1767900	1851100	1970100	2094100	
Max. Mom. ″#	1874300	1972500	2142500	2327100	2651800	2776700	2955100	3141200	
V.......	69400	75000	79200	87100	95900	101700	108000	116200	
P. feet..	9.00	8.77	9.02	8.91	9.22	9.10	9.12	9.01	
R.......	41000	45200	47900	52200	58700	62000	65300	69600	
W......	70200	75600	79200	86400	95440	95440	95440	95440	
Q. feet..	8.90	8.70	9.02	8.98	9.26	9.70	10.32	10.97	
w. lbs...	33	33	33	33	33	33	33	33	
Rivet dia....	1″	1″	1″	1″	1″	1″	1″	1″	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	139	139	150	150	158	158	174	174	192	192	203	203	216	216	232	232	
7	139	139	150	150	158	158	174	174	192	192	203	203	216	216	232	232	
8	139	139	150	150	158	158	174	174	192	192	203	203	216	216	232	232	
9	139	139	146	146	158	158	172	172	192	192	203	203	216	216	232	232	.101
10	125	125	132	132	143	143	155	155	177	177	185	185	197	197	209	209	.124
11	114	114	120	120	130	130	141	141	161	161	168	168	179	179	190	190	.150
12	104	104	110	110	119	119	129	129	147	147	154	154	164	164	175	175	.179
13	96	96	101	101	110	110	119	119	136	136	142	142	152	152	161	161	.210
14	89	88	94	93	102	101	111	110	126	126	132	132	141	141	150	150	.243
15	83	81	88	86	95	93	103	100	118	116	123	121	131	129	140	138	.279
16	78	75	82	79	89	85	97	93	111	107	116	112	123	119	131	127	.318
17	74	70	77	72	84	79	91	86	104	99	109	104	116	111	123	117	.359
18	69	64	73	67	79	73	86	80	98	92	103	96	109	102	116	109	.402
19	66	60	69	63	75	68	82	75	93	86	97	89	104	96	110	102	.448
20	63	56	66	59	71	63	78	70	88	80	93	84	99	90	105	95	.497
21	60	52	63	55	68	59	74	65	84	74	88	78	94	83	100	89	.547
22	57	49	60	51	65	55	71	61	80	70	84	73	90	78	95	83	.601
23	54	45	57	48	62	52	67	56	77	66	81	69	86	73	91	78	.651
24	52	42	55	45	60	49	65	53	74	62	77	64	82	69	87	73	.715
25	50	40	53	42	57	46	62	50	71	58	74	61	79	65	84	69	.776
26	48	37	51	40	55	43	60	47	68	54	71	57	76	61	81	65	.839
27	46	35	49	37	53	41	57	44	66	52	69	54	73	57	78	61	.905
28	45	33	47	35	51	38	55	41	63	48	66	51	70	54	75	58	.973
29	43	31	45	33	49	36	54	39	61	46	64	48	68	51	72	54	1.040
30	42	30	44	31	48	34	52	37	59	43	62	45	66	48	70	52	1.120
32	39	26	41	28	45	31	48	33	55	38	58	41	62	44	65	46	1.270
34	37	24	39	25	42	27	46	30	52	35	54	36	58	39	62	42	1.440
36	...	...	37	. .	40	. .	43	. .	.	...	51	33	55	35	58	37	1.610



BETHLEHEM GIRDER BEAMS

15" G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	14.75	14.88	15.00	15.12	
Wt. per foot.	127.0	135.0	141.0	147.0	
Area. Sq. In..	37.47	39.58	41.44	43.30	
b"......	11.680	11.720	11.750	11.780	
t.......	.730	.770	.800	.830	
h.......	11.908	11.908	11.908	11.908	
m......	1.421	1.486	1.546	1.606	
n.......	.965	1.030	1.090	1.150	
f.......	.90	.90	.90	.90	
c.......	10.250	10.250	10.250	10.250	
g.......	7½	7½	7½	7½	
u.......	1⅛	1 17/32	1 19/32	1 5/16	
AXES X-X I....	1415.6	1509.9	1596.8	1685.4	Live Load deflection must not exceed 1/360 of the Span.
AXES X-X S....	191.95	202.94	212.91	222.94	Live Load Def. = Total Def. × Live Load / Tabular Load
AXES X-X r....	6.15	6.18	6.21	6.24	
AXES Y-Y I....	289.1	309.7	328.5	347.5	
AXES Y-Y S....	49.5	52.9	55.9	59.0	
AXES Y-Y r....	2.78	2.80	2.82	2.83	
Coef. Str....	2303300	2435300	2554900	2675200	
Max. Mom. "#	3455000	3653000	3832300	4012800	
V.......	129200	137400	144000	150600	
P. feet..	8.91	8.86	8.87	8.88	
R......	79400	83700	87000	90300	
W......	95440	95440	95440	95440	
Q. feet..	12.07	12.76	13.38	14.02	
w. lbs...	33	33	33	33	
Rivet dia....	1"	1"	1"	1"	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	258	258	275	275	288	288	301	301	
7	258	258	275	275	288	288	301	301	
8	258	258	275	275	288	288	301	301	
9	256	256	271	271	284	284	297	297	.101
10	230	230	243	243	255	255	267	267	.124
11	209	209	221	221	232	232	243	243	.150
12	192	192	203	203	213	213	223	223	.179
13	177	177	187	187	197	197	206	206	.210
14	165	165	174	174	182	182	191	191	.243
15	154	153	162	161	170	169	178	177	.279
16	144	141	152	149	160	157	167	164	.318
17	136	131	143	138	150	145	157	152	.359
18	128	121	135	128	142	135	149	142	.402
19	121	113	128	120	134	125	141	132	.448
20	115	106	122	112	128	118	134	123	.497
21	110	99	116	105	122	110	127	115	.547
22	105	93	111	98	116	103	122	108	.601
23	100	87	106	92	111	97	116	101	.651
24	96	82	101	86	106	90	111	95	.715
25	92	77	97	81	102	86	107	90	.776
26	89	73	94	77	98	80	103	85	.839
27	85	68	90	72	95	76	99	80	.905
28	82	64	87	68	91	72	96	76	.973
29	79	61	84	65	88	68	92	71	1.040
30	77	58	81	61	85	64	89	67	1.120
32	72	52	76	55	80	58	84	61	1.270
34	68	47	72	50	75	52	79	55	1.440
36	...	...	68	45	71	47	74	49	1.610

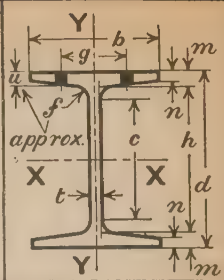
16" G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}''$ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



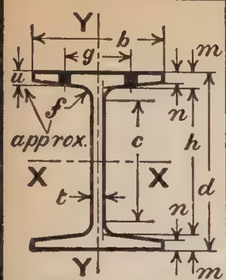
Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × $\frac{\text{Live Load}}{\text{Tabular Load}}$

Depth = d".		15.88	16.00	16.12	16.25
Wt. per foot.		74.5	81.0	87.0	94.0
Area. Sq. In.		21.96	23.82	25.68	27.75
b"		11.470	11.500	11.530	11.565
t		.390	.420	.450	.485
h		14.018	14.018	14.018	14.018
m		.931	.991	1.051	1.116
n		.469	.529	.589	.654
f		.60	.60	.60	.60
c		12.875	12.875	12.875	12.875
g		$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$
u		$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$
AXES X-X	I	1033.6	1131.3	1230.8	1341.4
	S	130.18	141.41	152.70	165.10
	r	6.86	6.89	6.92	6.95
AXES Y-Y	I	148.1	164.6	181.3	199.9
	S	25.8	28.6	31.5	34.6
	r	2.60	2.63	2.66	2.68
Coef. Str.		1562100	1696900	1832400	1981100
Max. Mom. "#		2343200	2545400	2748700	2971700
V		74300	80600	87000	94600
P. feet		10.51	10.53	10.53	10.47
R		41300	45700	50000	54600
W		70200	75600	81000	87300
Q. feet		11.13	11.22	11.31	11.35
w. lbs.		33	33	33	33
Rivet dia.		1"	1"	1"	1"

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
10	149	149	161	161	174	174	189	189	
11	142	142	154	154	167	167	180	180	
12	130	130	141	141	153	153	165	165	
13	120	120	131	131	141	141	152	152	
14	112	112	121	121	131	131	142	142	
15	104	103	113	112	122	121	132	131	.262
16	98	96	106	104	115	112	124	121	.298
17	92	88	100	96	108	104	117	113	.336
18	87	82	94	89	102	96	110	104	.377
19	82	76	89	83	96	89	104	97	.420
20	78	71	85	78	92	84	99	91	.466
21	74	66	81	73	87	78	94	85	.513
22	71	62	77	68	83	73	90	79	.563
23	68	59	74	64	80	69	86	74	.616
24	65	55	71	60	76	64	83	70	.670
25	63	52	68	56	73	61	79	66	.727
26	60	49	65	53	71	58	76	62	.787
27	58	46	63	50	68	54	73	58	.848
28	56	43	61	48	65	51	71	55	.912
29	54	41	59	45	63	48	68	52	.979
30	52	39	57	43	61	46	66	49	1.047
32	49	35	53	38	57	41	62	44	1.192
34	46	31	50	34	54	37	58	40	1.346
36	43	28	47	31	51	33	55	36	1.508



BETHLEHEM GIRDER BEAMS

18" G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}$" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".		17.88	18.00	18.12	18.25
Wt. per foot.		80.0	86.0	92.0	99.0
Area. Sq. In..		23.59	25.35	27.13	29.11
b"......		11.730	11.750	11.770	11.795
t.......		.420	.440	.460	.485
h.......		16.01	16.01	16.01	16.01
m......		.935	.995	1.055	1.120
n.......		.464	.524	.584	.649
f.......		.60	.60	.60	.60
c.......		14.875	14.875	14.875	14.875
g.......		$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$	$7\frac{1}{2}$
u.......		$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$
AXES X-X	I....	1380.7	1503.6	1628.5	1767.7
	S....	154.44	167.07	179.75	193.72
	r....	7.65	7.70	7.75	7.79
AXES Y-Y	I....	157.8	174.9	192.2	211.3
	S....	26.9	29.8	32.7	35.8
	r....	2.59	2.63	2.66	2.69
Coef. Str....		1853300	2004800	2157000	2324600
Max. Mom. "#		2779900	3007200	3235400	3487000
V.......		90100	95000	100000	106200
P. feet..		10.28	10.55	10.79	10.94
R......		46200	49500	52800	56900
W......		94500	99000	103500	109100
Q. feet..		9.81	10.13	10.42	10.65
w. lbs...		41	41	41	41
Rivet dia....		1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
8	180	180	190	190	200	200	212	212	
9	180	180	190	190	200	200	212	212	
10	180	180	190	190	200	200	212	212	
11	168	168	182	182	196	196	211	211	.125
12	154	154	167	167	180	180	194	194	.149
13	143	143	154	154	166	166	179	179	.175
14	132	132	143	143	154	154	166	166	.203
15	124	123	134	133	144	143	155	154	.233
16	116	114	125	123	135	132	145	142	.265
17	109	105	118	114	127	123	137	132	.299
18	103	98	111	105	120	114	129	123	.335
19	98	92	106	99	114	107	122	114	.373
20	93	85	100	92	108	99	116	107	.414
21	88	79	95	86	103	93	111	100	.456
22	84	74	91	81	98	87	106	94	.501
23	81	71	87	76	94	82	101	88	.548
24	77	66	84	72	90	77	97	83	.596
25	74	62	80	67	86	72	93	78	.647
26	71	58	77	63	83	68	89	73	.699
27	69	56	74	60	80	64	86	69	.754
28	66	52	72	57	77	61	83	66	.811
29	64	49	69	53	74	57	80	62	.870
30	62	47	67	51	72	54	77	58	.931
32	58	42	63	46	67	49	73	53	1.06
34	55	38	59	41	63	44	68	47	1.20
36	51	34	56	37	60	40	65	43	1.34
38	49	31	53	34	57	36	61	39	1.49
40	46	...	50	...	54	...	58	...	1.66

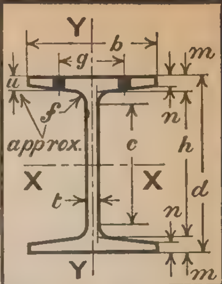
20" G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

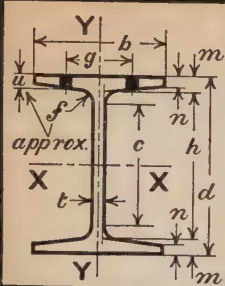
Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".	19.75	19.88	20.00	20.12	19.75	19.88	20.00	20.12	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.	99.0	107.0	113.0	120.0	127.0	135.0	142.0	149.0	
Area. Sq. In..	29.21	31.36	33.20	35.24	37.33	39.58	41.71	43.84	
b"......	11.950	11.980	12.000	12.030	12.690	12.720	12.750	12.780	
t.......	.510	.540	.560	.590	.600	.630	.660	.690	
h.......	17.626	17.626	17.626	17.626	17.170	17.170	17.170	17.170	
m......	1.062	1.127	1.187	1.247	1.289	1.354	1.414	1.474	
n.......	.585	.650	.710	.770	.785	.851	.911	.971	
f.......	.65	.65	.65	.65	.75	.75	.75	.75	
c.......	16.375	16.375	16.375	16.375	15.750	15.750	15.750	15.750	
g.......	7½	7½	7½	7½	7½	7½	7½	7½	
u.......	25/32	13/16	7/8	15/16	1"	1 1/16	1 3/32	1 5/32	
AXES X-X I....	2034.4	2206.5	2362.8	2528.0	2607.3	2788.9	2960.6	3134.9	
AXES X-X S....	206.02	221.98	236.28	251.29	264.03	280.57	296.06	311.62	
AXES X-X r....	8.35	8.39	8.44	8.47	8.36	8.39	8.43	8.46	
AXES Y-Y I....	202.1	222.4	240.8	260.2	313.0	337.7	361.0	384.6	
AXES Y-Y S....	33.8	37.1	40.1	43.3	49.3	53.1	56.6	60.2	
AXES Y-Y r....	2.63	2.66	2.69	2.72	2.90	2.92	2.94	2.96	
Coef. Str....	2472200	2663800	2835400	3015500	3168400	3366900	3552700	3739400	Total Deflection in inches for Maximum Load; Laterally fixed beam.
Max. Mom. "#	3708300	3995700	4253000	4523300	4752500	5050300	5329100	5609200	
V.......	120900	128800	134400	142500	142200	150300	158400	166600	
P. feet..	10.22	10.34	10.55	10.58	11.14	11.20	11.21	11.22	
R.......	62400	67200	70700	75200	76500	80300	84200	88000	
W......	114800	119300	119300	119300	119300	119300	119300	119300	
Q. feet..	10.77	11.16	11.88	12.64	13.28	14.11	14.89	15.67	
w. lbs...	41	41	41	41	41	41	41	41	
Rivet dia....	1"	1"	1"	1"	1"	1"	1"	1"	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span	Laterally		Laterally		Laterally		Laterally		Laterally		Laterally		Laterally		Laterally		
feet	fixed	free	fixed	free	fixed	free	fixed	free	fixed	free	fixed	free	fixed	free	fixed	free	
8	242	242	258	258	269	269	285	285	284	284	301	301	317	317	333	333	
9	242	242	258	258	269	269	285	285	284	284	301	301	317	317	333	333	
10	242	242	258	258	269	269	285	285	284	284	301	301	317	317	333	333	
11	225	225	242	242	258	258	274	274	284	284	301	301	317	317	333	333	
12	206	206	222	222	236	236	251	251	264	264	281	281	296	296	312	312	.134
13	190	190	205	205	218	218	232	232	244	244	259	259	273	273	288	288	.158
14	177	177	190	190	203	203	215	215	226	226	240	240	254	254	267	267	.183
15	165	165	178	178	189	189	201	201	211	211	224	224	237	237	249	249	.210
16	155	153	167	164	177	174	188	185	198	197	210	209	222	221	234	234	.239
17	145	141	157	152	167	162	177	172	186	183	198	195	209	206	220	217	.270
18	137	131	148	142	158	151	168	161	176	171	187	182	197	192	208	202	.302
19	130	122	140	132	149	140	159	150	167	160	177	170	187	179	197	189	.336
20	124	115	133	123	142	131	151	140	158	149	168	158	178	168	187	177	.373
21	118	107	127	116	135	123	144	131	151	140	160	149	169	157	178	166	.411
22	112	100	121	108	129	115	137	123	144	132	153	140	162	148	170	156	.451
23	108	95	116	102	123	108	131	115	138	124	146	131	154	139	163	147	.493
24	103	89	111	96	118	102	126	109	132	117	140	124	148	131	156	138	.537
25	99	84	107	91	113	96	121	103	127	110	135	117	142	124	150	131	.582
26	95	79	102	85	109	91	116	97	122	104	130	111	137	117	144	123	.630
27	92	75	99	81	105	86	112	91	117	98	125	105	132	111	139	117	.679
28	88	70	95	76	101	81	108	86	113	93	120	99	127	105	134	111	.736
29	85	66	92	72	98	77	104	82	109	88	116	94	123	100	129	105	.783
30	82	63	89	68	95	73	100	77	106	84	112	89	118	94	125	99	.838
32	77	56	83	61	89	65	94	69	99	76	105	80	111	85	117	90	.954
34	73	51	78	55	83	58	89	63	93	68	99	73	105	77	110	81	1.08
36	69	46	74	50	79	53	84	57	88	62	94	66	99	70	104	74	1.21
38	65	42	70	45	75	48	79	51	83	56	89	60	94	64	98	67	1.34
40	62	..	67	...	71	44	75	46	79	51	84	55	89	58	93	61	1.49



BETHLEHEM GIRDER BEAMS

22" G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".		21.88	22.00	22.12	22.25
Wt. per foot.		101.0	108.0	116.0	124.0
Area. Sq. In..		29.68	31.89	34.12	36.59
b"......		12.970	13.000	13.030	13.065
t.......		.450	.480	.510	.545
h.......		19.798	19.798	19.798	19.798
m.......		1.041	1.101	1.161	1.226
n.......		.519	.579	.639	.704
f.......		.65	.65	.65	.65
c.......		18.625	18.625	18.625	18.625
g.......		7½	7½	7½	7½
u.......		¾	13/16	⅞	15/16
AXES X-X	I....	2590.4	2804.3	3021.2	3261.7
	S....	236.78	254.94	273.16	293.19
	r....	9.34	9.38	9.41	9.44
AXES Y-Y	I....	238.1	261.9	286.0	312.6
	S....	36.7	40.3	43.9	47.9
	r....	2.83	2.87	2.90	2.92
Coef. Str....		2841400	3059200	3278000	3518200
Max.Mom."#		4262100	4588800	4917000	5277300
V.......		118200	126700	135400	145500
P. feet..		12.02	12.07	12.10	12.09
R.......		52300	57600	62900	69100
W......		121600	129600	137800	143160
Q. feet..		11.68	11.80	11.89	12.29
w. lbs...		49	49	49	49
Rivet dia....		1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
12	236	236	253	253	271	271	291	291	
13	219	219	235	235	252	252	271	271	
14	203	203	219	219	234	234	251	251	
15	189	189	204	204	219	219	235	235	
16	178	178	191	191	205	205	220	220	
17	167	167	180	178	193	191	207	205	.241
18	158	154	170	166	182	178	195	191	.274
19	150	144	161	155	173	167	185	179	.305
20	142	135	153	145	164	156	176	167	.339
21	135	126	146	137	156	146	168	157	.373
22	129	119	139	128	149	137	160	148	.410
23	124	112	133	121	143	130	153	139	.448
24	118	105	128	114	137	122	147	131	.488
25	114	100	122	107	131	115	141	124	.529
26	109	94	118	102	126	109	135	117	.572
27	105	89	113	96	121	103	130	111	.617
28	102	85	109	91	117	98	126	105	.664
29	98	80	106	87	113	93	121	99	.712
30	95	76	102	82	109	88	117	94	.762
32	89	69	96	74	102	79	110	85	.867
34	84	63	90	67	96	72	104	78	.979
36	79	56	85	61	91	65	98	70	1.10
38	75	52	81	56	86	59	93	64	1.22
40	71	47	77	51	82	54	88	58	1 35
42	68	43	73	46	78	50	84	53	1.49
44	65	...	70	...	75	...	80	...	1.64
46	62	...	67	...	71	...	76	...	1.79

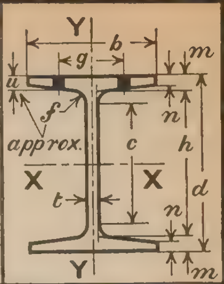
24" G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



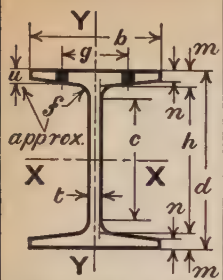
Depth = d".	23.78	23.88	24.00	24.12	23.88	24.00	24.12
Wt. per foot.	107.0	113.0	120.0	128.0	132.0	140.0	148.0
Area, Sq. In.	31.60	33.18	35.36	37.79	38.82	41.13	43.68
b".	12.195	12.210	12.240	12.280	13.210	13.240	13.280
t.	.485	.500	.530	.570	.570	.600	.640
h.	21.604	21.604	21.604	21.604	21.386	21.386	21.386
m.	1.088	1.138	1.198	1.258	1.247	1.307	1.367
n.	.600	.650	.710	.770	.720	.780	.840
f.	.65	.65	.65	.65	.70	.70	.70
c.	20.375	20.375	20.375	20.375	20.125	20.125	20.125
g.	7½	7½	7½	7½	7½	7½	7½
u.	25/32	13/16	7/8	15/16	15/16	1"	1 1/16
AXES X-X I.	3173.1	3363.3	3607.8	3867.1	3939.6	4201.3	4478.0
AXES X-X S.	266.87	281.68	300.65	320.66	329.95	350.11	371.31
AXES X-X r.	10.02	10.07	10.10	10.12	10.07	10.11	10.13
AXES Y-Y I.	220.0	236.1	256.3	277.5	329.9	355.6	382.5
AXES Y-Y S.	36.1	38.7	41.9	45.2	50.0	53.7	57.6
AXES Y-Y r.	2.64	2.67	2.69	2.71	2.92	2.94	2.96
Coef. Str.	3202500	3380200	3607800	3847900	3959300	4201300	4455700
Max. Mom. "#	4803700	5070300	5411700	5771800	5939000	6301900	6683600
V.	138400	143300	152600	165000	163300	172800	185200
P. feet.	11.57	11.79	11.82	11.66	12.12	12.16	12.03
R.	58800	61700	67500	75300	75200	81000	88800
W.	130980	135000	143160	143160	143160	143160	143160
Q. feet.	12.22	12.52	12.60	13.44	13.83	14.67	15.56
w. lbs.	49	49	49	49	49	49	49
Rivet dia.	1"	1"	1"	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
10	277	277	287	287	305	305	330	330	327	327	346	346	370	370	
11	277	277	287	287	305	305	330	330	327	327	346	346	370	370	
12	267	267	282	282	301	301	321	321	327	327	346	346	370	370	.112
13	246	246	260	260	278	278	296	296	305	305	323	323	343	343	.131
14	229	229	241	241	258	258	275	275	283	283	300	300	318	318	.152
15	214	214	225	225	241	241	257	257	264	264	280	280	297	297	.175
16	200	198	211	209	225	223	240	238	247	247	263	263	278	278	.199
17	188	183	199	194	212	207	226	221	233	231	247	245	262	260	.225
18	178	170	188	181	200	192	214	206	220	215	233	229	248	243	.251
19	169	160	178	168	190	180	203	192	208	201	221	214	235	227	.280
20	160	149	169	157	180	168	192	179	198	189	210	200	223	213	.310
21	153	140	161	148	172	158	183	168	189	178	200	188	212	200	.342
22	146	132	154	139	164	148	175	158	180	167	191	177	203	188	.375
23	139	123	147	130	157	139	167	148	172	157	183	167	194	177	.411
24	133	116	141	123	150	131	160	139	165	148	175	157	186	167	.447
25	128	109	135	115	144	123	154	132	158	140	168	148	178	158	.485
26	123	103	130	109	139	117	148	124	152	132	162	141	171	149	.525
27	119	98	125	103	134	110	143	118	147	126	156	133	165	141	.566
28	114	92	121	98	129	104	137	111	141	118	150	126	159	134	.608
29	110	87	117	92	124	98	133	106	137	113	145	120	154	127	.653
30	107	83	113	87	120	93	128	100	132	107	140	114	149	121	.698
32	100	74	106	79	113	84	120	89	124	97	131	102	139	109	.795
34	94	67	99	71	106	76	113	81	116	87	124	93	131	99	.897
36	89	61	94	64	100	68	107	73	110	80	117	85	124	90	1.01
38	84	55	89	58	95	62	101	66	104	72	111	77	117	82	1.12
40	80	50	85	53	90	57	96	60	99	66	105	70	111	75	1.24
42	76	...	80	...	86	...	92	...	94	60	100	64	106	68	1.37
44	73	...	77	...	82	...	87	...	90	56	95	59	101	63	1.50
46	70	...	73	...	78	...	84	...	86	...	91	...	97	...	1.64
48	67	...	70	...	75	...	80	...	82	...	88	...	93	...	1.79



BETHLEHEM GIRDER BEAMS

26" G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	25.81	25.88	26.00	26.12	
Wt. per foot.	138.0	144.0	151.0	160.0	
Area. Sq. In..	40.65	42.38	44.55	47.25	
b"......	13.700	13.730	13.750	13.790	
t.......	.580	.610	.630	.670	
h.......	23.336	23.336	23.336	23.336	
m......	1.237	1.272	1.332	1.392	
n.......	.690	.725	.785	.845	
f.......	.75	.75	.75	.75	
c.......	22.0	22.0	22.0	22.0	
g.......	10"	10"	10"	10"	
u.......	27/32	7/8	31/32	1 1/32	
AXES X-X I....	4779.9	4983.4	5289.8	5629.4	
AXES X-X S....	370.39	385.12	406.91	431.04	
AXES X-X r....	10.84	10.84	10.90	10.92	
AXES Y-Y I....	357.4	375.0	402.8	432.8	
AXES Y-Y S....	52.2	54.6	58.6	62.8	
AXES Y-Y r....	2.97	2.97	3.01	3.03	
Coef. Str....	4444700	4621400	4882900	5172500	
Max. Mom."#	6667000	6932100	7324300	7758700	
V.......	179600	189400	196600	210000	
P. feet..	12.37	12.20	12.42	12.32	
R.......	78500	84300	88300	96400	
W......	167000	167000	167000	167000	
Q. feet..	13.31	13.84	14.62	15.49	
w. lbs...	58	58	58	58	
Rivet dia....	1"	1"	1"	1"	

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
11	359	359	379	379	393	393	420	420	
12	359	359	379	379	393	393	420	420	
13	342	342	355	355	376	376	398	398	.121
14	317	317	330	330	349	349	369	369	.140
15	296	296	308	308	326	326	345	345	.161
16	278	278	289	289	305	305	323	323	.183
17	261	261	272	272	287	287	304	304	.207
18	247	244	257	254	271	268	287	284	.232
19	234	229	243	237	257	251	272	266	.258
20	222	214	231	223	244	235	259	250	.287
21	212	201	220	209	233	222	246	234	.316
22	202	189	210	197	222	208	235	221	.347
23	193	178	201	186	212	196	225	208	.379
24	185	168	193	176	203	185	215	196	.413
25	178	160	185	166	195	175	207	186	.448
26	171	151	178	157	188	166	199	176	.484
27	165	143	171	149	181	157	192	167	.522
28	159	136	165	141	174	149	185	158	.562
29	153	129	159	134	168	141	178	150	.602
30	148	122	154	127	163	135	172	143	.645
32	139	111	144	115	153	122	162	130	.733
34	131	101	136	105	144	111	152	117	.832
36	124	92	128	95	136	101	144	107	.928
38	117	84	122	87	128	92	136	98	1.03
40	111	76	116	80	122	84	129	89	1.15
42	106	...	110	73	116	77	123	82	1.26
44	101	...	105	67	111	71	118	76	1.39
46	97	...	100	...	106	...	112	...	1.52
48	93	...	96	...	102	...	108	...	1.65
50	89	...	92	...	98	...	103	...	1.79

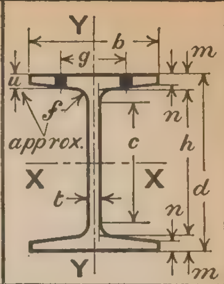
28" G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



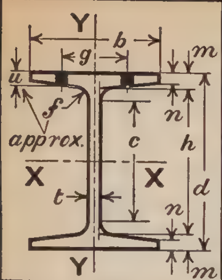
Depth = d".	27.75	27.88	28.00	28.12
Wt. per foot.	145.0	156.0	165.0	175.0
Area. Sq. In..	42.69	45.93	48.75	51.45
b"......	14.160	14.210	14.250	14.285
t.......	.585	.635	.675	.710
h.......	25.268	25.268	25.268	25.268
m......	1.241	1.306	1.366	1.426
n.......	.675	.740	.800	.860
f.......	.80	.80	.80	.80
c.......	23.750	23.750	23.750	23.750
g.......	10"	10"	10"	10"
u.......	27/32	29/32	31/32	1 1/32
AXES X-X I....	5772.3	6218.6	6624.6	7026.0
AXES X-X S....	416.02	446.10	473.19	499.72
AXES X-X r....	11.63	11.64	11.66	11.69
AXES Y-Y I....	389.8	425.4	458.3	491.1
AXES Y-Y S....	55.1	59.9	64.3	68.8
AXES Y-Y r....	3.02	3.04	3.07	3.09
Coef. Str....	4992300	5353200	5678200	5996600
Max. Mom."#	7488400	8029700	8517300	8994900
V.......	194800	212400	226800	239600
P. feet..	12.81	12.60	12.52	12.51
R.......	80000	90600	99100	106700
W......	167000	167000	167000	167000
Q. feet..	14.95	16.03	17.00	17.95
w. lbs...	58	58	58	58
Rivet dia....	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
12	390	390	425	425	454	454	479	479	
13	384	384	412	412	437	437	461	461	.113
14	357	357	382	382	406	406	428	428	.123
15	333	333	357	357	379	379	400	400	.150
16	312	312	335	335	355	355	375	375	.170
17	294	294	315	315	334	334	353	353	.193
18	277	276	297	296	315	314	333	332	.215
19	263	259	282	278	299	295	316	311	.240
20	250	243	268	261	284	277	300	292	.266
21	238	228	255	245	270	259	286	275	.293
22	227	215	243	230	258	245	273	259	.322
23	217	203	233	218	247	231	261	244	.352
24	208	192	223	205	237	219	250	231	.383
25	200	181	214	194	227	206	240	218	.416
26	192	172	206	184	218	195	231	207	.450
27	185	163	198	175	210	186	222	196	.485
28	178	154	191	166	203	176	214	186	.521
29	172	147	185	158	196	168	207	177	.559
30	166	139	178	150	189	159	200	169	.599
32	156	127	167	136	177	144	187	153	.681
34	147	115	157	124	167	132	176	139	.769
36	139	105	149	113	158	120	167	127	.862
38	131	96	141	103	149	109	158	116	.960
40	125	88	134	95	142	101	150	107	1.06
42	119	81	127	87	135	92	143	98	1.17
44	113	74	122	80	129	85	136	90	1.29
46	109	69	116	74	123	78	130	83	1.40
48	104	...	112	...	118	...	125	...	1.53
50	100	...	107	...	114	...	120	...	1.66
52	96	...	103	...	109	...	115	...	1.80



BETHLEHEM GIRDER BEAMS

30" G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".		29.88	30.00	30.12	30.25
Wt. per foot.		173.0	180.0	190.0	200.0
Area. Sq. In..		50.80	53.20	55.90	58.92
b"......		14.980	15.000	15.030	15.065
t.......		.660	.680	.710	.745
h.......		27.148	27.148	27.148	27.148
m......		1.366	1.426	1.486	1.551
n.......		.769	.829	.889	.954
f.......		.85	.85	.85	.85
c.......		25.625	25.625	25.625	25.625
g.......		10"	10"	10"	10"
u.......		31/32	1 1/32	1 3/32	1 5/32
AXES X-X	I....	7895.2	8343.1	8818.0	9343.8
	S....	528.46	556.21	585.52	617.77
	r....	12.47	12.52	12.56	12.59
AXES Y-Y	I....	519.1	555.1	592.7	634.2
	S....	69.3	74.0	78.9	84.2
	r....	3.20	3.23	3.26	3.28
Coef. Str....		6341500	6674500	7026300	7413300
Max. Mom."#		9512300	10011700	10539400	11119900
V.......		236600	244800	256600	270400
P. feet..		13.40	13.63	13.69	13.71
R.......		97200	101600	108400	116400
W......		190880	190880	190880	190880
Q. feet..		16.61	17.48	18.40	19.42
w. lbs...		66	66	66	66
Rivet dia....		1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × $\frac{\text{Live Load}}{\text{Tabular Load}}$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
13	473	473	490	490	513	513	541	541	
14	453	453	477	477	502	502	530	530	.122
15	423	423	445	445	468	468	494	494	.140
16	396	396	417	417	439	439	463	463	.159
17	373	373	393	393	413	413	436	436	.180
18	352	352	371	371	390	390	412	412	.201
19	334	333	351	350	370	369	390	389	.224
20	317	312	334	329	351	346	371	366	.248
21	302	294	318	310	335	326	353	344	.274
22	288	277	303	292	319	307	337	325	.300
23	276	262	290	276	305	290	322	306	.329
24	264	248	278	261	293	275	309	290	.358
25	254	235	267	247	281	260	297	275	.388
26	244	223	257	235	270	247	285	261	.420
27	235	212	247	223	260	234	275	248	.452
28	226	201	238	211	251	223	265	236	.487
29	219	192	230	201	242	212	256	225	.522
30	211	182	222	192	234	202	247	213	.559
32	198	166	209	175	220	184	232	195	.636
34	187	152	196	159	207	168	218	177	.718
36	176	138	185	145	195	153	206	162	.804
38	167	127	176	134	185	141	195	148	.896
40	159	117	167	123	176	130	185	136	.993
42	151	107	159	113	167	119	177	126	1.10
44	144	99	152	104	160	110	168	116	1.20
46	138	91	145	96	153	102	161	107	1.31
48	132	84	139	89	146	94	154	99	1.43
50	127	...	133	78	141	87	148	92	1.55
52	122	...	128	...	135	...	143	...	1.68
54	117	...	124	...	130	...	137	...	1.81

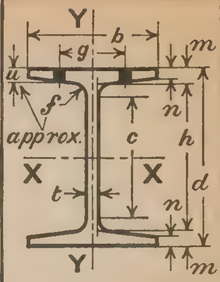
33″ G

BETHLEHEM GIRDER BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½″ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

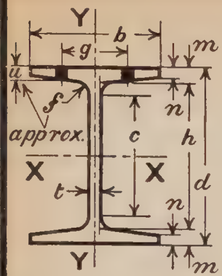
Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d″.	32.88	33.00	33.12	33.25	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.	202.0	210.0	220.0	230.0	
Area. Sq. In..	59.53	61.91	64.80	67.85	
b″......	15.735	15.750	15.780	15.810	
t.......	.720	.735	.765	.795	
h.......	29.904	29.904	29.904	29.904	
m.......	1.488	1.548	1.608	1.673	
n.......	862	.922	.982	1.047	
f.......	.90	.90	.90	.90	
c.......	28.250	28.250	28.250	28.250	
g.......	10″	10″	10″	10″	
u.......	13/32	15/32	17/32	19/32	
AXES X-X I....	11114	11671	12278	12935	
AXES X-X S....	676.03	707.33	741.43	778.05	
AXES X-X r....	13.66	13.73	13.77	13.81	
AXES Y-Y I....	667.3	708.5	752.2	799.6	
AXES Y-Y S....	84.8	90.0	95.3	101.2	
AXES Y-Y r....	3.35	3.38	3.41	3.43	
Coef. Str....	8112400	8488000	8897100	9336500	Total Deflection in inches for Maximum Load; Laterally fixed beam.
Max. Mom. ″#	12168600	12732000	13345700	14004800	
V......	284100	291100	304000	317200	
P. feet..	14.28	14.58	14.63	14.72	
R......	112700	116300	123600	130900	
W......	190880	190880	190880	190880	
Q. feet..	21.25	22.23	23.31	24.46	
w. lbs...	66	66	66	66	
Rivet dia....	1″	1″	1″	1″	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection
14	568		582		608		634		.111
16	507		531		556		584		.144
18	451		472		494		519		.183
20	406	404	424	422	445	443	467	465	.226
21	386	380	404	398	424	418	445	439	.249
22	369	359	386	376	404	394	424	413	.273
23	353	340	369	355	387	373	406	391	.298
24	338	321	354	337	371	353	389	371	.325
25	324	305	340	320	356	335	373	351	.353
26	312	290	326	303	342	318	359	334	.381
27	300	275	314	288	330	303	346	318	.411
28	290	262	303	274	318	288	333	302	.442
29	280	250	293	262	307	275	322	288	.475
30	270	238	283	249	297	262	311	274	.508
31	262	228	274	238	287	250	301	262	.542
32	254	219	265	227	278	238	292	250	.578
33	246	209	257	217	270	228	283	239	.614
34	239	199	250	208	262	218	275	229	.652
35	232	190	243	199	254	208	267	219	.691
36	225	182	236	191	247	200	259	209	.731
38	213	167	223	175	234	184	246	193	.815
40	203	154	212	161	222	169	233	177	.903
42	193	142	202	149	212	156	222	163	.995
44	184	131	193	137	202	144	212	151	1.09
46	176	121	185	127	193	133	203	140	1.19
48	169	112	177	118	185	123	195	130	1.30
50	162	104	170	109	178	115	187	121	1.41
52	156	97	163	101	171	107	180	112	1.53
54	150		157		165		173		1.65
56	145		152		159		167		1.77



BETHLEHEM GIRDER BEAMS

36" G

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	35.88	36.00	36.12	36.24	Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = Total Def. × Live Load / Tabular Load
Wt. per foot.	231.0	240.0	250.0	260.0	
Area, Sq. In.	67.85	70.55	73.61	76.50	
b"	16.480	16.500	16.530	16.555	
t	.770	.790	.820	.845	
h	32.706	32.706	32.706	32.706	
m	1.587	1.647	1.707	1.767	
n	.933	.993	1.053	1.113	
f	.95	.95	.95	.95	
c	31.000	31.000	31.000	31.000	
g	10"	10"	10"	10"	
u	1 3/16	1¼	1 5/16	1⅜	
AXES X-X I	14979	15696	16457	17205	
AXES X-X S	834.95	872.00	911.24	949.50	
AXES X-X r	14.86	14.92	14.95	15.00	
AXES Y-Y I	825.3	873.5	923.8	973.7	
AXES Y-Y S	100.2	105.9	111.8	117.6	
AXES Y-Y r	3.49	3.52	3.54	3.57	
Coef. Str.	10019400	10464000	10934900	11394000	Total Deflection in inches for Maximum Load; Laterally fixed beam.
Max.Mom."#	15029100	15696000	16402300	17091100	
V	331500	341300	355400	367500	
P. feet	15.11	15.33	15.38	15.50	
R	126900	132000	139700	146000	
W	190880	190880	190880	190880	
Q. feet	26.24	27.41	28.64	29.85	
w. lbs.	66	66	66	66	
Rivet dia.	1"	1"	1"	1"	

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection
16	626		654		683		712		.132
18	557		581		607		633		.167
20	501		523		547		570		.207
21	477	475	498	496	521	519	542	540	.228
22	455	448	476	469	497	490	518	511	.250
23	436	425	455	444	475	463	495	483	.273
24	417	402	436	420	455	439	475	458	.298
25	401	382	418	399	437	417	456	435	.323
26	385	363	402	379	420	396	438	413	.350
27	371	345	387	360	405	377	422	394	.377
28	358	329	374	344	390	359	407	375	.406
29	345	313	361	328	377	343	393	358	.435
30	334	300	349	313	364	327	380	342	.466
31	323	286	337	299	353	313	367	326	.497
32	313	274	327	286	342	299	356	312	.530
33	304	262	317	273	331	286	345	298	.563
34	295	251	308	262	322	274	335	285	.598
35	286	240	299	251	312	262	325	273	.634
36	278	230	291	241	304	252	316	262	.670
38	264	212	275	221	288	232	300	242	.747
40	250	195	262	205	273	213	285	223	.828
42	239	181	249	189	260	197	271	206	.912
44	228	167	238	175	248	182	259	191	1.001
46	218	155	227	162	238	170	248	177	1.094
48	209	144	218	150	228	158	237	164	1.191
50	200	134	209	140	219	147	228	153	1.293
52	193	125	201	130	210	136	219	142	1.399
54	186	117	194	122	202	127	211	133	1.508
56	179		187		195		203		1.622
58	173		180		189		196		1.704

ALLOWABLE END REACTIONS FOR BETHLEHEM GIRDER BEAMS
DETERMINED BY
BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight per foot	Web t	Unit Stress in Buckling	Reaction R for 3½″ Bearing	Min. Span for 3½″ Bearing	Reaction R for 5½″ Bearing	Increase in R for 1″ Additional Bearing	Max. Web Shear V	Length of Bearing to develop V
8	29.5	.285″	15000	23400	6.55′	32000	4280	26900	4.32″
	33.0	.290	15000	23900	7.29	32600	4350	27800	4.39
	36.5	.310	15000	25700	7.62	35000	4650	30200	4.46
9	36.0	.290	15000	25000	8.62	31100	4350	31100	4.90
	38.5	.310	15000	26700	8.58	33500	4650	33500	4.96
	43.5	.350	15000	30200	8.50	38300	5260	38300	5.05
10	41.5	.310	15000	27900	9.81	36900	4650	36900	5.44
	44.5	.320	15000	28800	10.27	38400	4800	38400	5.50
	50.0	.360	15000	32400	10.15	43200	5400	43700	5.60
12	51.5	.360	15000	35100	11.50	45900	5400	51500	6.54
	55.5	.380	15000	37100	11.74	48500	5700	54700	6.60
	61.0	.410	15000	40000	11.97	52300	6150	59700	6.70
	66.0	.450	15000	43900	11.44	57400	6750	64100	6.49
	70.5	.470	15000	45800	11.87	59900	7050	67700	6.60
	76.5	.510	15000	49700	11.84	65000	7650	74200	6.70
15	64.5	.390	14510	41000	15.24	52400	5660	69400	8.51
	69.0	.420	14850	45200	14.55	57700	6240	75000	8.27
	74.0	.440	15000	47900	14.91	61100	6600	79200	8.25
	80.5	.480	15000	52200	14.86	66600	7200	87100	8.35
	94.0	.540	15000	58700	15.06	74900	8100	95900	8.09
	99.0	.570	15000	62000	14.93	79100	8550	101700	8.15
	105.0	.600	15000	65300	15.09	83300	9000	108000	8.25
	111.0	.640	15000	69600	15.04	88800	9600	116200	8.35
	127.0	.730	15000	79400	14.51	101300	10950	129200	8.05
	135.0	.770	15000	83700	14.54	106800	11550	137400	8.15
	141.0	.800	15000	87000	14.68	111000	12000	144000	8.25
	147.0	.830	15000	90300	14.81	115200	12450	150600	8.34
16	74.5	.390	14100	41300	18.91	52300	5500	74300	9.49
	81.0	.420	14490	45700	18.57	57800	6090	80600	9.23
	87.0	.450	14830	50000	18.32	63400	6670	87000	9.04
	94.0	.485	15000	54600	18.14	69100	7280	94600	8.99
18	80.0	.420	13820	46200	20.06	57800	5800	90100	11.06
	86.0	.440	14070	49500	20.25	61900	6190	95000	10.85
	92.0	.460	14300	52800	20.43	66000	6580	100000	10.67
	99.0	.485	14560	56900	20.43	71000	7060	106200	10.48

The beam web is treated as a column with fixed ends, having an effective length L of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.

When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

ALLOWABLE END REACTIONS FOR BETHLEHEM GIRDER BEAMS

DETERMINED BY

BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

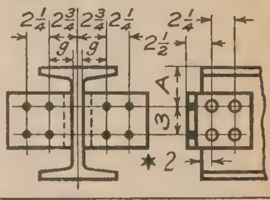
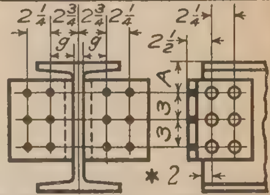
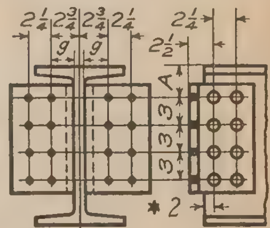
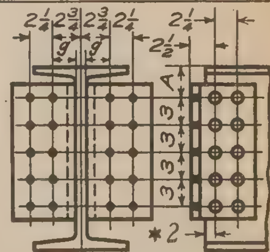
Depth in Inches	Weight per foot	Web t	Unit Stress in Buckling	Reaction R for 3½" Bearing	Min. Span for 3½" Bearing	Reaction R for 5½" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V	Length of Bearing to develop V
20	99.0	.51"	14400	62400	19.81'	77100	7340	120900	11.47"
	107.0	.540	14650	67200	19.82	83000	7910	128800	11.28
	113.0	.560	14850	70700	20.05	87300	8320	134400	11.16
	120.0	.590	15000	75200	20.05	92900	8850	142500	11.10
	127.0	.600	15000	76500	20.71	94500	9000	142200	10.80
	135.0	.630	15000	80300	20.97	99200	9450	150300	10.90
	142.0	.660	15000	84200	21.10	104000	9900	158400	11.00
	149.0	.690	15000	88000	21.25	108700	10350	166600	11.10
22	101.0	.450	12910	52300	27.16	63900	5810	118200	14.84
	108.0	.480	13330	57600	26.56	70400	6400	126700	14.30
	116.0	.510	13700	62900	26.06	76900	6990	135400	13.87
	124.0	.545	14090	69100	25.46	84500	7680	145500	13.45
24	107.0	.485	12850	58800	27.23	71300	6230	138400	16.27
	113.0	.500	13040	61700	27.39	74800	6520	143300	16.01
	120.0	.530	13420	67500	26.72	81800	7110	152600	15.46
	128.0	.570	13860	75300	25.55	91100	7900	165000	14.86
	132.0	.570	13930	75200	26.33	91100	7940	163300	14.60
	140.0	.600	14210	81000	25.93	98100	8530	172800	14.26
	148.0	.640	14560	88800	25.09	107500	9320	185200	13.84
26	138.0	.580	13530	78500	28.31	94200	7850	179600	16.38
	144 0	.610	13820	84300	27.41	101100	8430	189400	16.00
	151.0	.630	14020	88300	27.65	106000	8830	196600	15.76
	160.0	.670	14390	96400	26.83	115700	9640	210000	15.30
28	145.0	.585	13090	80000	31.20	95300	7660	194800	18.40
	156.0	.635	13620	90600	29.54	107900	8650	212400	17.58
	165.0	.675	13990	99100	28.65	118000	9440	226800	17.03
	175.0	.710	14270	106700	28.10	126900	10130	239600	16.62
30	173.0	.660	13420	97200	32.62	114900	8860	236600	19.23
	180.0	.680	13590	101600	32.85	120100	9240	244800	18.99
	190.0	.710	13850	108400	32.41	128100	9830	256600	18.57
	200 0	.745	14120	116400	31.84	137400	10520	270400	18.14
33	202 0	.720	13360	112700	35.99	132000	9620	284100	21.31
	210 0	.735	13470	116300	36.49	136100	9900	291100	21.15
	220 0	.765	13710	123600	35.99	144600	10490	304000	20.70
	230 0	.795	13940	130900	35.66	153000	11080	317200	20.32
36	231.0	.770	13220	126900	39.48	147300	10180	331500	23.59
	240.0	.790	13370	132000	39.64	153100	10560	341300	23.32
	250 0	.820	13600	139700	39.14	162000	11150	355400	22.84
	260.0	.845	13780	146000	39.02	169500	11640	367500	22.51

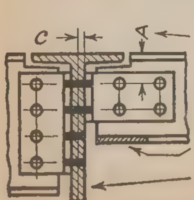
The beam web is treated as a column with fixed ends, having an effective length L of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.

When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

CONNECTION ANGLES FOR BETHLEHEM GIRDER BEAMS

DIMENSIONS, WEIGHTS AND WORKING LOADS — 3/4" POWER DRIVEN RIVETS

Beam: Depth	Beam: Weight per foot	Connection Value: Web	Connection Value: Outstanding Single Shear: Power Driven Rivets	Connection Value: Outstanding Single Shear: Unfinished Bolts	Framing Distance C	Connection Angles: A.I.S.C. Mark	Connection Angles: Gage g	Connection Angles: Size and Length	Connection Angles: Weight inc. Web Rivets	Connection Details.
8"	31.0	25650	47720	35340	3/16	IC.16.10	2 5/8	6" × 6" × 3/8" 0' — 5½" Long	16 lbs.	
	33.0	26100	47720	35340	3/16	IC.16.10	2 5/8			
	37.0	27920	47720	35340	3/16	IC.16.10	2 5/8			
9"	36.0	26100	47720	35340	3/16	IC.16.10	2 5/8			
	38.5	27900	47720	35340	1/4	IC.16.10	2 5/8			
	43.5	31500	47720	35340	3/16	IC.16.10	2 5/8			
10"	41.5	27900	47720	35340	1/4	IC.16.10	2 5/8			
	44.5	28800	47720	35340	1/4	IC.16. 9	2 9/16			
	50.0	32400	47720	35340	1/4	IC.16. 9	2 9/16			
12"	51.5	48600	71580	53020	1/4	IC.24. 9	2 9/16	6" × 6" × 3/8" 0' — 8½" Long	24 lbs.	
	55.5	51300	71580	53020	1/4	IC.24. 9	2 9/16			
	61.0	55350	71580	53020	1/4	IC.24. 9	2 9/16			
	66.0	60750	71580	53020	5/16	IC.24. 8	2 ½			
	70.5	63450	71580	53020	5/16	IC.24. 8	2 ½			
	76.5	68850	71580	53020	5/16	IC.24. 8	2 ½			
15"	64.5	70200	95440	70690	1/4	IC.33. 9	2 9/16	6" × 6" × 3/8" 0' — 11½" Long	33 lbs.	
	69.0	75600	95440	70690	1/4	IC.33. 9	2 9/16			
	74.0	79200	95440	70690	5/16	IC.33. 8	2 ½			
	80.5	86400	95440	70690	5/16	IC.33. 8	2 ½			
	94.0	95440	95440	70690	5/16	IC.33. 8	2 ½			
	99.0	95440	95440	70690	3/8	IC.33. 7	2 7/16			
	105.0	95440	95440	70690	3/8	IC.33. 7	2 7/16			
	111.0	95440	95440	70690	3/8	IC.33. 7	2 7/16			
	127.0	95440	95440	70690	7/16	*				
	135.0	95440	95440	70690	7/16	*				
	141.0	95440	95440	70690	7/16	*				
	147.0	95440	95440	70690	1/2	*				
16"	74.5	70200	95440	70690	1/4	IC.33. 9	2 9/16			
	81.0	75600	95440	70690	1/4	IC.33. 9	2 9/16			
	87.0	81000	95440	70690	5/16	IC.33. 8	2 ½			
	94.0	87300	95440	70690	5/16	IC.33. 8	2 ½			
18"	80.0	94500	119300	88360	1/4	IC.41. 7	2 7/16	6" × 6" × 3/8" 1' — 2½" Long	41 lbs.	
	86.0	99000	119300	88360	5/16	IC.41. 8	2 ½			
	92.0	103500	119300	88360	5/16	IC.41. 8	2 ½			
	99.0	109100	119300	88360	5/16	IC.41. 8	2 ½			
20"	99.0	114800	119300	88360	5/16	IC.41. 8	2 ½			
	107.0	113900	119300	88360	5/16	IC.41. 8	2 ½			
	113.0	119300	119300	88360	3/8	IC.41. 8	2 ½			
	120.0	119300	119300	88360	3/8	IC.41. 7	2 7/16			
	127.0	119300	119300	88360	3/8	IC.41. 7	2 7/16			
	135.0	119300	119300	88360	3/8	IC.41. 7	2 7/16			
	142.0	119300	119300	88360	3/8	IC.41. 7	2 7/16			
	149.0	119300	119300	88360	7/16	IC.41. 7	2 7/16			



*Special Connections must be used for 15", *127*, *135*, *141*, and *147 lb.*, Girder Beams. The values given are for 8 web and 16 field rivets.

Following Beams can be framed opposite with tops flush when:—
A = 2¾" all 8", 9", 10", 12", 15" to *80.5 lb.*, and 16".
A = 3" all 9", 10", 12", 15"*, 16", 18", 20", 22", and 24", to *129 lb.*
A = 3¼" all 9", 10", 12", 15", to *80.5 lb.*, 16", 18", *93* and *100 lb.*, 20", 22", 24" and 26".
A = 3½" all 10", 12", 20", 22", 24", 26", 28" and 30".

Flange must be cut away as shown for field riveting on all beams framing opposite a larger beam, if flange interferes with outstanding rivets.

Minimum Web required to develop Single Shearing Value is .33"
Minimum Web required to develop Double Shearing Value is .53"

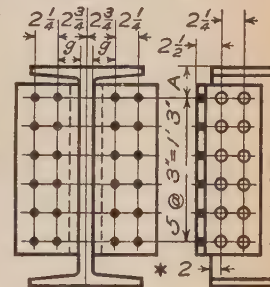
CONNECTION ANGLES FOR BETHLEHEM GIRDER BEAMS

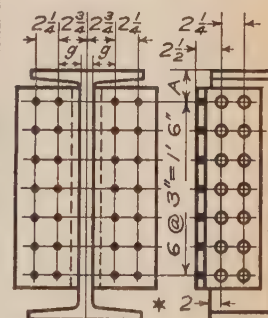
DIMENSIONS, WEIGHTS, AND WORKING LOADS

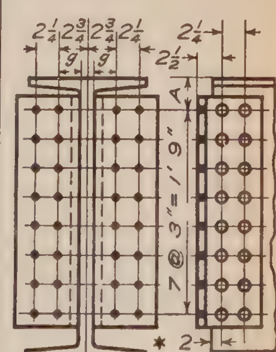
3/4" POWER DRIVEN RIVETS

Beam		Connection Value			Framing Distance	Connection Angles			
			Outstanding Single Shear						
Depth	Weight per foot	Web	Power Driven Rivets	Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets
22"	101.0	121600	143160	106030	5/16	IC.49. 8	2 1/2	6" × 6" × 3/8" 1' — 5 1/2" Long	49 lbs.
	108.0	129600	143160	106030	5/16	IC.49. 8	2 1/2		
	116.0	137800	143160	106030	5/16	IC.49. 8	2 1/2		
	124.0	143160	143160	106030	5/16	IC.49. 8	2 1/2		
24"	107.0	130980	143160	106030	5/16	IC.49. 8	2 1/2		
	113.0	135000	143160	106030	5/16	IC.49. 8	2 1/2		
	120.0	143160	143160	106030	5/16	IC.49. 8	2 1/2		
	128.0	143160	143160	106030	3/8	IC.49. 7	2 7/16		
	132.0	143160	143160	106030	3/8	IC.49. 7	2 7/16		
	140.0	143160	143160	106030	3/8	IC.49. 7	2 7/16		
	148.0	143160	143160	106030	3/8	IC.49. 7	2 7/16		
26"	138.0	167020	167020	123700	3/8	IC.58. 7	2 7/16	6" × 6" × 3/8" 1' — 8 1/2" Long	58 lbs.
	144.0	167020	167020	123700	3/8	IC.58. 7	2 7/16		
	151 0	167020	167020	123700	3/8	IC.58. 7	2 7/16		
	160.0	167020	167020	123700	3/8	IC.58. 7	2 7/16		
28"	145.0	167020	167020	123700	3/8	IC.58. 7	2 7/16		
	156.0	167020	167020	123700	3/8	IC.58. 7	2 7/16		
	165.0	167020	167020	123700	3/8	IC.58. 7	2 7/16		
	175.0	167020	167020	123700	7/16	IC.58. 6	2 3/8		
30"	173.0	190880	190880	141380	3/8	IC.66. 7	2 7/16	6" × 6" × 3/8" 1' — 11 1/2" Long	66 lbs.
	180.0	190880	190880	141380	3/8	IC.66. 7	2 7/16		
	190.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
	200.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
33"	202.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
	210.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
	220.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
	230.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
36"	231.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
	240.0	190880	190880	141380	7/16	IC.66. 6	2 3/8		
	250.0	190880	190880	141380	1/2	IC.66. 5	2 5/16		
	260.0	190880	190880	141380	1/2	IC.66. 5	2 5/16		

Connection Details







*Layer-out starts with this dimension at left end of beam. With beams ordered one inch short, as usual in standard shop practice, this leaves sufficient end distance or clearance at right end, in case of full allowable 1/2" underrun or 1/2" overrun in beam lengths.

NOTES and DIAGRAMS

Part IV

Section 7

Carnegie Beam Sections

Dimensions

Technical Functions

Allowable Total Loads

by

A. I. S. C. Specification

Allowable End Reactions

Standard Connection Angles

Usual Stock Sizes	
Depth	Weight
8″	24.0 #
9	29.0
10	21.0
12	25.0
14	30.0
16	35.0
18	47.0
21	58.0
24	70.0
27	91.0
30	115.0

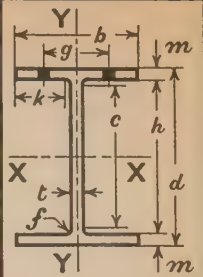
8" C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



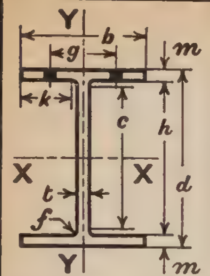
Depth = d".	8.000	8.098	8.196	8.060	8.198	8.360
Wt. per foot.	24.0	27.0	30.0	31.0	36.0	42.0
Area	7.06	7.93	8.81	9.10	10.58	12.34
b."	6.500	6.529	6.559	8.000	8.046	8.100
t.	.239	.268	.298	.290	.336	.390
h.	7 3/16	7 3/16	7 3/16	7 3/16	7 3/16	7 3/16
m.	.400	.449	.498	.430	.499	.580
k.	2 11/16	2 11/16	2 11/16	3 3/8	3 3/8	3 3/8
f.	.45	.45	.45	.45	.45	.45
c.	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4
g.	3"	3"	3"	5 1/2	5 1/2	5 1/2
AXES X-X I.	84.3	95.9	107.8	110.9	131.3	156.2
AXES X-X S.	21.08	23.68	26.31	27.52	32.03	37.37
AXES X-X r.	3.46	3.48	3.50	3.49	3.52	3.56
AXES Y-Y I.	18.3	20.8	23.4	36.7	43.4	51.4
AXES Y-Y S.	5.6	6.4	7.1	9.2	10.8	12.7
AXES Y-Y r.	1.61	1.62	1.63	2.01	2.02	2.04
Coef. Str.	252900	284200	315700	330200	384400	448400
Max.Mom."#	379400	426300	473500	495300	576600	672600
V.	22900	26000	29300	28100	33100	39100
P. feet	5.52	5.46	5.38	5.88	5.81	5.74
R.	19720	22210	24800	23990	27970	32700
W.	21510	23860	23860	26100	30240	35100
Q. feet	5.88	5.95	6.62	6.32	6.35	6.38
w lbs.	13	13	13	16	16	16
Rivet dia.	3/4	3/4	3/4	7/8	7/8	7/8

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span	Laterally		Laterally		Laterally		Laterally		Laterally		Laterally		Total Deflection in inches for Maximum Load; Laterally fixed beam.
feet	fixed	free	fixed	free	fixed	free	fixed	free	fixed	free	fixed	free	
3	45.9	45.9	52.1	52.1	58.6	58.6	56.1	56.1	66.1	66.1	78.2	78.2	
4	45.9	45.9	52.1	52.1	58.6	58.6	56.1	56.1	66.1	66.1	78.2	78.2	
5	45.9	45.9	52.1	52.1	58.6	58.6	56.1	56.1	66.1	66.1	78.2	78.2	
6	42.1	42.1	47.3	47.3	52.6	52.6	55.0	55.0	64.1	64.1	74.8	74.8	.084
7	36.1	36.1	40.6	40.6	45.1	45.1	47.2	47.2	54.9	54.9	64.1	64.1	.114
8	31.6	31.6	35.5	35.5	39.5	39.5	41.3	41.3	48.0	48.0	56.1	56.1	.149
9	28.1	27.5	31.6	30.9	35.1	34.3	36.7	36.7	42.7	42.7	49.8	49.8	.189
10	25.3	24.0	28.4	27.0	31.6	30.1	33.0	33.0	38.4	38.4	44.9	44.9	.233
11	23.0	21.2	25.8	23.8	28.7	26.5	30.0	29.4	34.9	34.2	40.8	40.0	.281
12	21.1	18.8	23.7	21.2	26.3	23.5	27.5	26.3	32.0	30.6	37.4	36.6	.335
13	19.4	16.8	21.9	18.9	24.3	21.1	25.4	23.7	29.6	27.6	34.5	32.3	.394
14	18.1	15.1	20.3	16.9	22.6	18.9	23.6	21.5	27.5	25.0	32.0	29.3	.456
15	16.9	....	18.9	....	21.1	....	22.0	....	25.6	....	29.9	26.6	.524
16	15.8	....	17.8	....	19.7	....	20.6	....	24.0	....	28.0	....	.596
17	14.9	....	16.7	....	18.6	....	19.4	....	22.6	....	26.4	....	.674
18	14.1	....	15.8	....	17.5	....	18.3	....	21.4	....	24.9	....	.754
19	13.3	....	15.0	....	16.6	....	17.4	....	20.2	....	23.6	....	.840
20	12.6	....	14.2	....	15.8	....	16.5	....	19.2	....	22.4	....	.931
21	12.0	....	13.5	....	15.0	....	15.7	....	18.3	....	21.5	....	1.03
22	11.5	....	12.9	....	14.4	....	15.0	....	17.5	....	20.4	....	1.13
23	11.0	....	12.4	....	13.7	....	14.4	....	16.7	....	19.5	....	1.23
24	10.5	....	11.8	....	13.2	....	13.8	....	16.0	....	18.7	....	1.34
25	10.1	....	11.4	....	12.6	....	13.2	....	15.4	....	17.9	....	1.46



CARNEGIE BEAMS

9" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	9.000	9.096	9.192	9.000	9.122	9.242
Wt. per foot.	29.0	32.0	35.0	38.0	43.0	48.0
Area	8.53	9.40	10.29	11.17	12.65	14.11
b"	6.500	6.528	6.556	9.000	9.041	9.082
t	.279	.307	.335	.316	.357	.398
h	8"	8"	8"	8"	8"	8"
m	.470	.518	.566	.470	.531	.591
k	2⅝	2⅝	2⅝	3 13/16	3 13/16	3 13/16
f	.50	.50	.50	.50	.50	.50
c	7"	7"	7"	7"	7"	7"
g	3"	3"	3"	5½	5½	5½
AXES X-X I	126.0	140.5	155.4	170.4	195.5	221.1
AXES X-X S	28.00	30.89	33.81	37.87	42.86	47.85
AXES X-X r	3.84	3.87	3.89	3.91	3.93	3.96
AXES Y-Y I	21.5	24.0	26.6	57.1	65.4	73.8
AXES Y-Y S	6.6	7.4	8.1	12.7	14.5	16.3
AXES Y-Y r	1.59	1.60	1.61	2.26	2.28	2.29
Coef. Str.	336000	370700	405700	454400	514400	574200
Max. Mom. "#	504000	556100	608600	681600	771500	861200
V	30100	33500	37000	34100	39100	44100
P. feet	5.58	5.53	5.49	6.66	6.59	6.50
R	24060	26590	29130	27250	30950	34690
W	23860	23860	23860	28440	32130	35820
Q. feet	7.04	7.77	8.50	6.98	8.00	8.01
w lbs	13	13	13	16	16	16
Rivet dia.	¾	¾	¾	⅞	⅞	⅞

Live Load Deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	60.3	60.3	67.0	67.0	73.9	73.9	68.3	68.3	78.2	78.2	88.3	88.3	
4	60.3	60.3	67.0	67.0	73.9	73.9	68.3	68.3	78.2	78.2	88.3	88.3	
5	60.3	60.3	67.0	67.0	73.9	73.9	68.3	68.3	78.2	78.2	88.3	88.3	
6	56.0	56.0	61.8	61.8	67.6	67.6	68.3	68.3	78.2	78.2	88.3	88.3	
7	48.0	48.0	53.0	53.0	58.0	58.0	64.9	64.9	73.5	73.5	82.0	82.0	.101
8	42.0	42.0	46.4	46.4	50.7	50.7	56.8	56.8	64.3	64.3	71.8	71.8	.132
9	37.3	36.5	41.2	40.3	45.1	44.1	50.5	50.5	57.2	57.2	63.8	63.8	.168
10	33.6	31.9	37.1	35.2	40.6	38.7	45.4	45.4	51.4	51.4	57.4	57.4	.207
11	30.5	28.2	33.7	31.1	36.9	34.0	41.3	41.3	46.8	46.8	52.2	52.2	.250
12	28.0	24.9	30.9	27.6	33.8	30.3	37.9	37.3	42.9	42.2	47.8	47.3	.298
13	25.8	22.3	28.5	24.6	31.2	27.1	35.0	33.8	39.6	38.3	44.2	42.7	.350
14	24.0	20.0	26.5	22.1	29.0	24.2	32.5	30.7	36.7	34.9	41.0	38.9	.406
15	22.4	18.0	24.7	19.9	27.1	21.8	30.3	28.1	34.3	31.8	38.3	35.6	.466
16	21.0	16.3	23.2	17.9	25.4	19.7	28.4	25.7	32.2	29.1	35.9	32.5	.530
17	19.8	....	21.8	....	23.9	....	26.7	....	30.3	....	33.8	....	.599
18	18.7	....	20.6	....	22.5	....	25.2	....	28.6	....	31.9	....	.670
19	17.7	....	19.5	....	21.4	....	23.9	....	27.1	....	30.2	....	.747
20	16.8	....	18.5	....	20.3	....	22.7	....	25.7	....	28.7	....	.828
21	16.0	....	17.7	....	19.3	....	21.6	....	24.5	....	27.3	....	.912
22	15.3	....	16.9	....	18.4	....	20.7	....	23.4	....	26.1	....	1.00
23	14.6	....	16.1	....	17.6	....	19.8	....	22.4	....	25.0	....	1.10
24	14.0	....	15.4	....	16.9	....	18.9	....	21.4	....	23.9	....	1.19
25	13.4	....	14.8	....	16.2	....	18.2	....	20.6	....	23.0	....	1.29

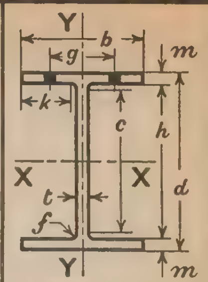
10″ C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½″ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



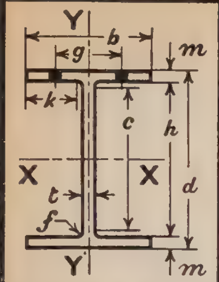
Depth = d″	9.902	10.000	10.098	10.228
Wt. per foot	21.0	23.0	26.0	30.0
Area	6.17	6.76	7.64	8.82
b″	6.000	6.000	6 029	6.068
t	230	.230	.259	.298
h	9³⁄₁₆	9³⁄₁₆	9³⁄₁₆	9³⁄₁₆
m	.332	.381	.430	.495
k	2⁹⁄₁₆	2⁹⁄₁₆	2⁹⁄₁₆	2⁹⁄₁₆
f	.30	.30	.30	.30
c	8⅝	8⅝	8⅝	8⅝
g	3″	3″	3″	3″
AXES X-X I	107.6	122.2	139.5	163.2
AXES X-X S	21.73	24.44	27.63	31.91
AXES X-X r	4.18	4.25	4.27	4.30
AXES Y-Y I	12.0	13.7	15.7	18.5
AXES Y-Y S	4.0	4.6	5.2	6.1
AXES Y-Y r	1.39	1.43	1.43	1.45
Coef. Str.	260800	293300	331500	382900
Max.Mom.″#	391200	439900	497300	574400
V	27300	27600	31400	36600
P. feet	4.76	5.30	5.28	5.23
R	18900	18890	22410	27070
W	20700	20700	23310	23860
Q feet	6.29	7.08	7.11	8.02
w lbs.	13	13	13	13
Rivet dia.	¾	¾	¾	¾

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	55	55	55	55	63	63	73	73	
4	55	55	55	55	63	63	73	73	
5	52	52	55	55	63	63	73	73	
6	44	44	49	49	55	55	64	64	.067
7	37	37	42	42	47	47	55	55	.091
8	33	32	37	36	41	41	48	47	.119
9	29	28	33	31	37	35	43	41	.151
10	26	24	29	27	33	31	38	36	.186
11	24	21	27	24	30	27	35	31	.225
12	22	19	24	21	28	24	32	29	.268
13	20	17	23	19	26	21	30	25	.315
14	19	15	21	17	24	19	27	22	.365
15	17	13	20	15	22	17	26	20	.419
16	16	12	18	14	21	15	24	18	.477
17	15	11	17	12	20	14	23	16	.539
18	15	...	16	...	18	13	21	15	.603
19	14	...	15	...	18	...	20	...	.672
20	13	...	15	...	17	...	19	...	.745
21	12	...	14	...	16	...	18	...	.821
22	12	...	13	...	15	...	17	...	.901
23	11	...	13	...	14	...	17	...	.986
24	11	...	12	...	14	...	16	...	1.07
25	10	...	12	...	13	...	15	...	1.16



CARNEGIE BEAMS

10" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d"	10.0	10.0	10.0	10.0	10.0	10.0
Wt. per foot	31.0	36.0	42.0	49.0	56.0	63.0
Area	9.11	10.58	12.35	14.41	16.47	18.53
b"	8.000	8.147	8.324	9.000	9.206	9.412
t	.320	.467	.644	.375	.581	.787
h	9 3/16	9 3/16	9 3/16	8¾	8¾	8¾
m	.381	.381	.381	.610	.610	.610
k	3 9/16	3 9/16	3 9/16	3⅞	3⅞	3⅞
f	.30	.30	.30	.45	.45	.45
c	8⅝	8⅝	8⅝	7⅞	7⅞	7⅞
g	4"	4"	4"	5½	5½	5½
AXES X-X I	163.4	175.6	190.4	266.0	283.2	300.4
AXES X-X S	32.68	35.12	38.08	53.20	56.64	60.08
AXES X-X r	4.23	4.07	3.93	4.30	4.15	4.03
AXES Y-Y I	32.5	34.4	36.8	74.2	79.5	85.2
AXES Y-Y S	8.1	8.5	8.9	16.5	17.3	18.1
AXES Y-Y r	1.89	1.80	1.73	2.27	2.20	2.14
Coef. Str.	392200	421400	457000	638400	679700	721000
Max.Mom."#	588200	632200	685400	957600	1019500	1081400
V	38400	56000	77300	45000	69700	94400
P. feet	5 11	3.76	2.96	7 09	4.87	3.82
R	28800	42030	57960	33750	52290	70830
W	28800	42030	47720	33750	47720	47720
Q feet	6.81	5.01	4.79	9.45	7.12	7.55
w lbs.	16	16	16	16	16	16
Rivet dia.	⅞	⅞	⅞	⅞	⅞	⅞

Live Load deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \text{Total Def.} \times \frac{\text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	77	77	112	112	152	152	90	90	139	139	189	189	
4	77	77	105	105	114	114	90	90	139	139	180	180	
5	77	77	84	84	91	91	90	90	136	136	144	144	
6	65	65	70	70	76	76	90	90	113	113	120	120	
7	56	56	60	60	65	65	90	90	97	97	103	103	
8	49	49	53	53	57	57	80	80	85	85	90	90	.119
9	44	44	47	47	51	51	71	71	76	76	80	80	.151
10	39	39	42	42	46	46	64	64	68	68	72	72	.186
11	36	35	38	38	42	41	58	58	62	62	66	66	.225
12	33	31	35	34	38	37	53	52	57	56	60	60	.268
13	30	28	32	30	35	33	49	48	52	51	56	54	.315
14	28	26	30	28	33	30	46	43	49	46	52	49	.365
15	26	23	28	25	31	28	43	39	45	42	48	45	.419
16	25	21	26	23	29	25	40	36	43	39	45	41	.477
17	23	19	25	21	27	23	38	33	40	36	42	38	.539
18	22	...	23	...	25	...	36	...	38	...	40	..	.603
19	21	..	22	...	24	...	34	...	36	...	38	...	.672
20	20	..	21	...	23	...	32	..	34	...	36	..	.745
21	19	...	20	...	22	...	30	...	32	...	34	.	821
22	18	..	19	...	21	...	29	..	31	...	33	...	.901
23	17	...	18	...	20	...	28	...	30	.	31	.	.986
24	16	...	18	...	19	...	27	...	28	...	30	..	1 07
25	16	..	17	..	18	...	26	..	27	...	29	...	1.16

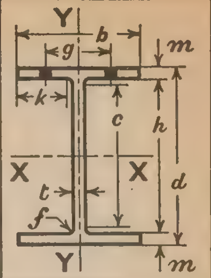
12" C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



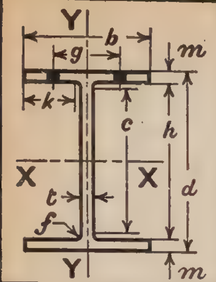
Depth = d".	11.924	12.000	12.118	*12.022	12.236	12.000	12.130	12.258
Wt. per foot.	25.0	28.0	32.0	34.0	36.0	40.0	45.0	50.0
Area	7.34	8.22	9.40	9.99	10.59	11.76	13.23	14.69
b"	6.000	6.500	6.534	6.635	6.568	8.000	8.036	8.071
t	.240	.240	.274	.375	.308	.290	.326	.361
h	11⅛	11⅛	11⅛	11⅛	11⅛	10 15/16	10 15/16	10 15/16
m	.382	.420	.479	.431	.538	.526	.591	.655
k	2½	2¾	2¾	2¾	2¾	3⅜	3⅜	3⅜
f	.35	.35	.35	.35	.35	.50	.50	.50
c	10⅜	10⅜	10⅜	10⅜	10⅜	9⅞	9⅞	9⅞
g	3"	3½	3½	3½	3½	4"	4"	4"
AXES X-X I	183.0	213.4	246.3	238.1	280.1	313.7	356.9	400.5
AXES X-X S	30.69	35.57	40.65	39.61	45.78	52.28	58.85	65.35
AXES X-X r	4.99	5.10	5.12	4.88	5.14	5.17	5.19	5.22
AXES Y-Y I	13.8	19.2	22.3	21.0	25.4	44.9	51.2	57.5
AXES Y-Y S	4.6	5.9	6.8	6.3	7.7	11.2	12.7	14.2
AXES Y-Y r	1.37	1.53	1.54	1.45	1.55	1.95	1.97	1.98
Coef. Str.	368300	426800	487800	475300	549400	627400	706100	784100
Max. Mom."#	552500	640200	731700	713000	824100	941100	1059200	1176200
V	34300	34600	39800	45100	45200	41800	47500	53100
P. feet	5.36	6.18	6.13	4.39	6.08	7.51	7.43	7.39
R	19840	19820	24290	36590	28790	26400	31140	35550
W	21600	21600	23860	23860	23860	23860	23860	23860
Q feet	8.53	9.88	10.22	9.96	11.51	13.14	14.79	16.43
w lbs.	13	13	13	13	13	13	13	13
Rivet dia.	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞

Live Load deflection must not exceed 1/360 of the Span.
Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least.
For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	69	69	69	69	80	80	108	108	90	90	84	84	95	95	106	106	
4	69	69	69	69	80	80	108	108	90	90	84	84	95	95	106	106	
5	69	69	69	69	80	80	95	95	90	90	84	84	95	95	106	106	
6	61	61	69	69	80	80	79	79	90	90	84	84	95	95	106	106	
7	53	53	61	61	70	70	68	68	79	79	84	84	95	95	106	106	
8	46	45	53	53	61	61	59	59	69	69	78	78	88	88	98	98	.099
9	41	39	47	46	54	53	53	52	61	60	70	70	79	79	87	87	.126
10	37	34	43	41	49	47	48	46	55	52	63	63	71	71	78	78	.155
11	34	30	39	36	44	41	43	40	50	46	57	56	64	63	71	70	.188
12	31	27	36	32	41	36	40	36	46	41	52	50	59	56	65	63	.223
13	28	24	33	28	38	32	37	32	42	37	48	45	54	51	60	57	.263
14	26	21	31	25	35	29	34	29	39	33	45	41	50	46	56	51	.304
15	25	19	29	23	33	26	32	26	37	30	42	37	47	42	52	47	.341
16	23	17	27	21	31	24	30	23	34	27	39	34	44	38	49	43	.398
17	22	15	25	19	29	21	28	21	32	24	37	31	42	35	46	39	.449
18	21	14	24	17	27	20	26	19	31	22	35	28	39	32	44	36	.503
19	19	13	23	16	26	18	25	18	29	20	33	26	37	30	41	33	.560
20	18	11	21	14	24	16	24	16	28	18	31	24	35	27	39	30	.621
21	18	...	20	13	23	15	23	15	26	17	30	22	34	25	37	28	.684
22	17	...	19	...	22	...	22	...	25	...	29	...	32	...	36	...	.751
23	16	...	19	...	21	...	21	...	24	...	27	...	31	...	34	...	.822
24	15	...	18	...	20	...	20	...	23	...	26	...	29	...	33	...	.894
25	15	...	17	...	19	...	19	...	22	...	25	...	28	...	31	...	.970

* Special Sections. Web Thickness ⅜".



CARNEGIE BEAMS

12" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000
Wt. per foot.	55.0	60.0	65.0	70.0	75.0	83.0	91.0	100.0
Area sq. in.	16.17	17.64	19.11	20.58	22.06	24.41	26.76	29.40
b"	9.000	9.122	9.245	9.367	10.500	10.696	10.892	11.112
t	.375	.497	.620	.742	.486	.682	.878	1.098
h	10⅝	10⅝	10⅝	10⅝	10⅜	10⅜	10⅜	10⅜
m	.665	.665	.665	.665	.800	.800	.800	.800
k	3¾	3¾	3¾	3¾	4 7/16	4 7/16	4 7/16	4 7/16
f	.55	.55	.55	.55	.55	.55	.55	.55
c	9½	9½	9½	9½	9¼	9¼	9¼	9¼
g	5½	5½	5½	5½	5½	5½	5½	5½
AXES X-X I	428.4	446.0	463.7	481.2	578.5	606.8	635.0	666.7
AXES X-X S	71.40	74.33	77.28	80.20	96.42	101.13	105.83	111.12
AXES X-X r	5.15	5.03	4.93	4.84	5.12	4.99	4.87	4.76
AXES Y-Y I	80.9	84.3	87.8	91.5	154.5	163.5	172.9	184.2
AXES Y-Y S	18.0	18.5	19.0	19.5	29.4	30.6	31.8	33.1
AXES Y-Y r	2.24	2.19	2.14	2.11	2.65	2.59	2.54	2.50
Coef. Str.	856800	892000	927400	962400	1157000	1213600	1270000	1333400
Max. Mom. "#	1285200	1337900	1391000	1443600	1735600	1820300	1904900	2000200
V	54000	71600	89300	106900	70000	98200	126400	158100
P. feet	7.93	6.23	5.19	4.50	8.27	6.18	5.02	4.22
R	36560	48460	60450	72350	47390	66500	85610	107060
W	50630	67100	71580	71580	65610	71580	71580	71580
Q. feet	8.46	6.65	6.48	6.72	8.82	8.48	8.87	9.31
w. lbs.	24	24	24	24	24	24	24	24
Rivet dia.	⅞	⅞	⅞	⅞	1"	1"	1"	1"

Live Load Deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	108	108	143	143	179	179	214	214	140	140	196	196	253	253	316	316	
4	108	108	143	143	179	179	214	214	140	140	196	196	253	253	316	316	
5	108	108	143	143	179	179	193	193	140	140	196	196	253	253	267	267	
6	108	108	143	143	155	155	160	160	140	140	196	196	212	212	222	222	
7	108	108	127	127	133	133	138	138	140	140	173	173	181	181	191	191	
8	107	107	112	112	116	116	120	120	140	140	152	152	159	159	167	167	.099
9	95	95	99	99	103	103	107	107	129	129	135	135	141	141	148	148	.126
10	86	86	89	89	93	93	96	96	116	116	121	121	127	127	133	133	.155
11	78	78	81	81	84	84	88	88	105	105	110	110	116	116	121	121	.188
12	71	70	74	74	77	77	80	80	96	96	101	101	106	106	111	111	.223
13	66	64	69	67	71	70	74	72	89	89	93	93	98	98	103	103	.263
14	61	58	64	60	66	63	69	66	83	81	87	86	91	90	95	95	.304
15	57	53	60	55	62	58	64	60	77	75	81	79	85	83	89	87	.341
16	54	49	56	51	58	53	60	55	72	69	76	73	79	76	83	81	.398
17	50	45	53	47	55	49	57	51	68	64	71	67	75	71	78	75	.449
18	48	41	50	43	52	45	54	47	64	59	67	62	71	66	74	69	.503
19	45	38	47	40	49	42	51	44	61	55	64	58	67	61	70	64	.560
20	43	35	45	37	46	39	48	40	58	51	61	54	64	57	67	60	.621
21	41	33	43	34	44	36	46	37	55	48	58	50	61	53	64	56	.684
22	39	...	41	...	42	...	44	...	53	...	55	...	58	...	61	...	.751
23	37	...	39	...	40	...	42	...	50	...	53	...	55	...	58	...	.822
24	36	...	37	...	39	...	40	...	48	...	51	...	53	...	56	...	.894
25	34	...	35	...	37	...	38	...	46	...	49	...	51	...	53	...	.970

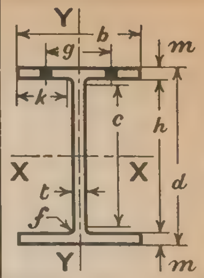
14" C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".	13.964	14.000	14.080	*14.000	14.160	14.240
Wt. per foot.	30.0	33.0	36.0	38.0	39.0	42.0
Area	8.82	9.71	10.58	11.18	11.47	12.35
b"	6.000	6.750	6.774	6.855	6.798	6.822
t	.270	.270	.294	.375	.318	.342
h	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16	13 1/16
m	.431	.449	.489	.449	.529	.569
k	2 7/16	2 13/16	2 13/16	2 13/16	2 13/16	2 13/16
f	.40	.40	.40	.40	.40	.40
c	12¼	12¼	12¼	12¼	12¼	12¼
g	3"	3½	3½	3½	3½	3½
AXES X-X I	292.0	333.4	365.6	357.5	398.3	431.5
AXES X-X S	41.82	47.63	51.93	51.07	56.26	60.60
AXES X-X r	5.75	5.86	5.88	5.66	5.89	5.91
AXES Y-Y I	15.5	23.0	25.4	24.2	27.7	30.2
AXES Y-Y S	5.2	6.8	7.5	7.1	8.2	8.8
AXES Y-Y r	1.33	1.54	1.55	1.47	1.56	1.56
Coef. Str.	501900	571500	623200	612900	675100	727200
Max.Mom."#	752800	857300	934800	919300	1012600	1090900
V	45200	45400	49700	63000	54000	58400
P. feet	5.54	6.30	6.27	4.87	6.25	6.22
R	23500	23490	26880	38340	30290	33720
W	24300	24300	26460	33750	28620	30780
Q. feet	10.32	11.75	11.78	9.08	11.79	11.81
w lbs.	19	19	19	19	19	19
Rivet dia.	⅞	⅞	⅞	⅞	⅞	⅞

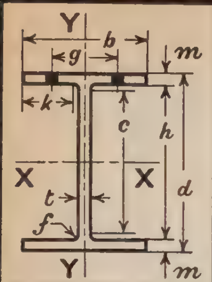
Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least.
For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
4	91	91	91	91	99	99	126	126	108	108	117	117	
5	91	91	91	91	99	99	123	123	108	108	117	117	
6	84	84	91	91	99	99	102	102	108	108	117	117	
7	72	72	82	82	89	89	88	88	96	96	104	104	.065
8	63	62	72	72	78	78	77	77	84	84	91	91	.085
9	56	53	64	63	69	68	68	67	75	74	81	80	.108
10	50	47	57	55	62	60	61	59	68	65	73	70	.133
11	46	41	52	49	57	53	56	52	61	57	66	62	.161
12	42	36	48	43	52	47	51	47	56	51	61	55	.192
13	39	32	44	39	48	42	47	42	52	46	56	49	.225
14	36	29	41	35	45	38	44	37	48	41	52	44	.261
15	34	26	38	31	42	34	41	34	45	37	49	40	.299
16	31	23	36	28	39	31	38	31	42	34	46	36	.341
17	32	21	34	26	37	28	36	28	40	30	43	33	.384
18	28	19	32	23	35	25	34	25	38	28	40	30	.431
19	26	17	30	21	33	23	32	23	36	25	38	27	.480
20	25	16	29	20	31	21	31	21	34	23	36	25	.532
21	24	...	27	18	30	20	29	19	32	21	35	23	.587
22	23	...	26	16	28	18	28	18	31	20	33	21	.644
23	22	...	25	...	27	...	27	...	29	...	32	...	.704
24	21	...	24	...	26	...	26	...	28	...	30	...	.766
25	20	...	23	...	25	...	25	...	27	...	29	...	.831
26	19	...	22	...	24	...	24	...	26	...	28	...	.899
27	19	...	21	...	23	...	23	...	25	...	27	...	.970
28	18	...	20	...	22	...	22	...	24	...	26	...	1.043
29	17	...	20	...	21	...	21	...	23	...	25	...	1.119
30	17	...	19	...	21	...	20	...	23	...	24	...	1.197

* Special Section. Web Thckiness ⅜".



CARNEGIE BEAMS

14" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

	Depth = d".	14.000	14.122	14.242	14.094	14.238	14.382	14.000	14.186	14.370
	Wt. per foot.	48.0	53.0	58.0	61.0	68.0	75.0	85.0	95.0	105.0
	Area	14.12	15.59	17.05	17.94	19.99	22.05	24.99	27.93	30.88
	b"	8.000	8.035	8.070	10.000	10.043	10.086	12.000	12.050	12.101
	t	.343	.378	.413	.382	.425	.468	.435	.485	.536
	h	12¾	12¾	12¾	12¾	12¾	12¾	12⅜	12⅜	12⅜
	m	.595	.656	.716	.642	.714	.786	.805	.898	.990
	k	3¼	3¼	3¼	4¼	4¼	4¼	5⅛	5⅛	5⅛
	f	.55	.55	.55	.55	.55	.55	.65	.65	.65
	c	11⅝	11⅝	11⅝	11⅝	11⅝	11⅝	11"	11"	11"
	g	4"	4"	4"	5½	5½	5½	7½	7½	7½
AXES X-X	I	496.0	552.5	609.4	656.2	738.8	823.5	921.3	1044.0	1169.6
AXES X-X	S	70.86	78.25	85.58	93.12	103.78	114.52	131.61	147.19	162.78
AXES X-X	r	5.93	5.95	5.98	6.05	6.08	6.11	6.07	6.11	6.15
AXES Y-Y	I	50.8	56.8	62.8	107.1	120.6	134.5	232.0	262.0	292.6
AXES Y-Y	S	12.7	14.1	15.6	21.4	24.0	26.7	38.7	43.5	48.4
AXES Y-Y	r	1.90	1.91	1.92	2.44	2.46	2.47	3.05	3.06	3.08
	Coef. Str.	850300	939000	1026900	1117400	1245300	1374200	1579400	1766200	1953400
	Max. Mom. "#	1275400	1408400	1540400	1676100	1868000	2061300	2369100	2649400	2930100
	V	57600	64100	70600	64600	72600	80800	73100	82600	92400
	P. feet	7.38	7.32	7.28	8.65	8.58	8.51	10.80	10.70	10.57
	R	33820	38810	43740	39360	45000	49810	45670	51260	57020
	W	46300	51030	55760	51570	57370	63180	58730	65470	71580
	Q. feet	9.18	9.20	9.21	10.83	10.85	10.88	13.45	13.49	13.64
	w. lbs.	24	24	24	24	24	24	24	24	24
	Rivet dia.	⅞	⅞	⅞	1"	1"	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
4	115	115	128	128	141	141	129	129	145	145	162	162	146	146	165	165	185	185	
5	115	115	128	128	141	141	129	129	145	145	162	162	146	146	165	165	185	185	
6	115	115	128	128	141	141	129	129	145	145	162	162	146	146	165	165	185	185	
7	115	115	128	128	141	141	129	129	145	145	162	162	146	146	165	165	185	185	
8	106	106	117	117	128	128	129	129	145	145	162	162	146	146	165	165	185	185	
9	95	95	104	104	114	114	124	124	138	138	153	153	146	146	165	165	185	185	
10	85	85	94	94	103	103	112	112	125	125	137	137	146	146	165	165	185	185	
11	77	76	85	84	93	92	102	102	113	113	125	125	144	144	161	161	178	178	.161
12	71	68	78	75	86	82	93	93	104	104	115	115	132	132	147	147	163	163	.192
13	65	61	72	67	79	74	86	85	96	95	106	105	122	122	136	136	150	150	.225
14	61	55	67	61	73	67	80	78	89	87	98	96	113	113	126	126	140	140	.261
15	57	50	63	56	69	61	75	71	83	79	92	88	105	105	118	118	130	130	.299
16	53	46	59	51	64	56	70	66	78	73	86	81	99	97	110	109	122	121	.341
17	50	42	55	46	60	51	66	60	73	68	81	75	93	90	104	101	115	112	.384
18	47	39	52	43	57	47	62	56	69	62	76	69	88	84	98	94	109	104	.431
19	45	35	49	39	54	43	59	52	66	58	72	64	83	78	93	88	103	97	.480
20	43	33	47	36	51	40	56	48	62	54	69	60	79	73	88	82	98	91	.532
21	41	30	45	33	49	37	53	45	59	50	65	55	75	69	84	77	93	85	.587
22	39	28	43	31	47	34	51	42	57	47	63	52	72	64	80	72	89	80	.644
23	37	26	41	29	45	31	49	39	54	44	60	48	69	60	77	68	85	75	.704
24	35	24	39	27	43	29	47	37	52	41	57	45	66	57	74	64	81	71	.766
25	34	22	38	25	41	27	45	34	50	38	55	42	63	54	71	60	78	67	.831
26	33	...	36	...	40	...	43	...	48	...	53	...	61	...	68	...	75	...	.899
27	32	...	35	...	38	...	41	...	46	...	51	...	59	...	65	...	72	...	.970
28	30	...	34	...	37	...	40	...	45	...	49	...	56	...	63	...	70	...	1.043
29	29	...	32	...	35	...	39	...	43	...	47	...	54	...	61	...	67	...	1.119
30	28	...	31	...	34	...	37	...	42	...	46	...	53	...	59	...	65	...	1.197

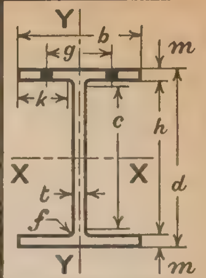
16" C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".	15.930	16.012	16.000	*15.934	16.128	16.254	16.000	16.114	16 226
Wt. per foot.	35.0	38.0	40.0	43.0	45.0	50.0	58.0	63.0	68.0
Area	10.29	11.17	11.75	12.65	13.23	14.70	17.06	18.52	20.00
b"	6.000	6.024	7.000	7.085	7.036	7.072	8.500	8.531	8.563
t	.290	.314	.290	.375	.326	.362	.375	.406	.438
h	14 15/16	14 15/16	14 15/16	14 15/16	14 15/16	14 15/16	14 5/8	14 5/8	14 5/8
m	.485	.526	.520	.487	.584	.647	.663	.720	.776
k	2 3/8	2 3/8	2 7/8	2 7/8	2 7/8	2 7/8	3 7/16	3 7/16	3 7/16
f	.45	.45	.45	.45	.45	.45	.65	.65	.65
c	14"	14"	14"	14"	14"	14"	13 3/8	13 3/8	13 3/8
g	3"	3"	4"	4"	4"	4"	5½	5½	5½
AXES X-X I	435.5	475.1	524.6	523.8	595.0	666.0	776.6	849.9	923.7
AXES X-X S	54.68	59.34	65.58	65.75	73.78	81.95	97.08	105.49	113.85
AXES X-X r	6.50	6.52	6.68	6.44	6.71	6.73	6.75	6.77	6.80
AXES Y-Y I	17.5	19.2	29.8	28.9	34.0	38.2	68.0	74.6	81.3
AXES Y-Y S	5.8	6.4	8.5	8.2	9.7	10.8	16.0	17.5	19.0
AXES Y-Y r	1.30	1.31	1.59	1.51	1.60	1.61	2.00	2.01	2.02
Coef. Str.	656100	712100	786900	789000	885400	983400	1164900	1265800	1366200
Max. Mom. "#	984200	1068200	1180400	1183400	1328100	1475100	1747400	1898700	2049400
V	55400	60300	55700	71700	63100	70600	72000	78500	85300
P. feet	5.92	5.90	7.07	5.50	7.02	6.96	8.09	8.06	8.01
R	25990	29590	25970	38830	31390	36890	38840	43580	48480
W	26100	28260	26100	33750	29340	32580	67500	73080	78840
Q. feet	12.56	12.59	15.06	11.69	15.09	15.09	8.63	8.66	8.66
w lbs.	19	19	19	19	19	19	33	33	33
Rivet dia.	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞

Live Load deflection must not exceed 1/360 of the Span.

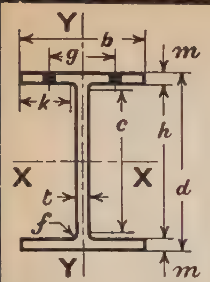
Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
5	111	111	121	121	111	111	143	143	126	126	141	141	144	144	157	157	171	171	
6	109	109	118	118	111	111	132	132	126	126	141	141	144	144	157	157	171	171	
7	94	94	102	102	111	111	113	113	126	126	140	140	144	144	157	157	171	171	
8	82	81	89	88	98	98	99	99	111	111	123	123	144	144	157	157	171	171	
9	73	70	79	76	87	87	88	87	98	98	109	109	129	129	141	141	152	152	.094
10	66	61	71	66	79	77	79	77	89	86	98	95	117	117	127	127	137	137	.116
11	60	53	65	58	72	68	72	68	80	76	89	84	106	105	115	114	124	123	.141
12	55	47	59	51	66	61	66	61	74	68	82	76	97	94	106	102	114	111	.168
13	51	42	55	45	61	54	61	54	68	61	76	68	90	85	97	93	105	100	.197
14	47	37	51	41	56	48	56	49	63	54	70	61	83	77	90	84	98	91	.228
15	44	34	47	36	52	43	53	42	59	49	66	55	78	70	84	77	91	83	.262
16	41	30	44	33	49	40	49	40	55	45	61	50	73	65	79	70	85	76	.298
17	39	27	42	30	46	36	47	37	52	41	58	46	69	59	75	64	80	70	.336
18	37	25	40	27	44	33	44	33	49	37	55	42	65	54	70	59	76	64	.377
19	35	22	37	24	41	30	42	30	47	34	52	38	61	50	67	55	72	59	.420
20	33	20	36	22	39	27	40	28	44	31	49	35	58	46	63	50	68	55	.466
21	31	...	34	...	37	25	38	26	42	28	47	32	56	43	60	47	65	50	.513
22	30	...	32	...	36	23	36	24	40	26	45	29	53	40	58	43	62	47	.563
23	29	...	31	...	34	21	34	22	38	24	43	27	51	37	55	40	59	43	.616
24	27	...	30	...	33	...	33	...	37	...	41	...	49	34	53	37	57	40	.670
25	26	...	28	...	31	...	32	...	35	...	39	...	47	32	51	35	55	38	.727
26	25	...	27	...	30	...	30	...	34	...	38	...	45	30	49	33	53	35	.787
27	24	...	26	...	29	...	29	...	33	...	36	...	43	28	47	30	51	33	.848
28	24	...	25	...	28	...	28	...	32	...	35	...	42	26	45	28	49	31	.912
29	23	...	25	...	27	...	27	...	31	...	34	...	40	...	44	...	47	...	.979
30	22	...	24	...	26	...	26	...	30	...	33	...	39	...	42	...	46	...	1.047
31	21	...	23	...	25	...	26	...	29	...	32	...	38	...	41	...	44	...	1.118
32	21	...	22	...	25	...	25	...	28	...	31	...	36	...	40	...	43	...	1.192
33	20	...	22	...	24	...	24	...	27	...	30	...	35	...	38	...	41	...	1 267

* Special Section. Web Thickness ⅜"

LOADS BY A. I. S C. SPECIFICATION



CARNEGIE BEAMS

16" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	16.000	16.120	16 240	16.000	16.110	16.236
Wt. per foot	76.0	83 0	90.0	100.0	107.0	115 0
Area	22.34	24.41	26.46	29 41	31.46	33.82
b"	12.000	12.039	12.076	14.000	14.032	14.068
t	.419	.458	.495	.464	496	.532
h	14⅝	14⅝	14⅝	14⅜	14⅜	14⅜
m	.663	.723	.783	.800	.855	.918
k	5⅛	5⅛	5⅛	6^1/16	6^1/16	6^1/16
f	.65	.65	.65	.70	.70	.70
c	13⅜	13⅜	13⅜	13"	13"	13"
g	7½	7½	7½	10"	10"	10"
AXES X-X I	1061.3	1167.7	1275.5	1426.8	1537.2	1665.6
AXES X-X S	132.66	144.88	157.08	178.35	190.84	205.17
AXES X-X r	6.89	6.92	6.94	6.97	6.99	7.02
AXES Y-Y I	191.1	210.4	230.0	366.0	393.9	426.2
AXES Y-Y S	31.8	35.0	38.1	52.3	56.1	60.6
AXES Y-Y r	2.92	2.94	2.95	3.53	3.54	3.55
Coef. Str.	1591900	1738500	1885000	2140200	2290000	2462100
Max.Mom."#	2387900	2607800	2827500	3210300	3435100	3693100
V	80500	88600	96500	89100	95900	103700
P. feet	9.90	9.81	9.77	12.01	11.94	11.88
R	45510	51450	56130	52200	56000	60320
W	75420	82440	89100	83520	89280	95440
Q. feet	10.55	10.54	10.58	12.81	12.82	12 90
w lbs	33	33	33	33	33	33
Rivet dia.	1"	1"	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
5	161	161	177	177	193	193	178	178	192	192	207	207	
6	161	161	177	177	193	193	178	178	192	192	207	207	
7	161	161	177	177	193	193	178	178	192	192	207	207	
8	161	161	177	177	193	193	178	178	192	192	207	207	
9	161	161	177	177	193	193	178	178	192	192	207	207	
10	159	159	174	174	189	189	178	178	192	192	207	207	
11	145	145	158	158	171	171	178	178	192	192	207	207	
12	133	133	145	145	157	157	178	178	191	191	205	205	
13	123	123	134	134	145	145	165	165	176	176	189	189	.197
14	114	114	124	124	135	135	153	153	164	164	176	176	.228
15	106	106	116	116	126	126	143	143	153	153	164	164	.262
16	100	98	109	107	118	116	134	134	143	143	154	154	.298
17	94	91	102	99	111	108	126	126	135	135	145	145	.336
18	88	85	97	92	105	100	119	118	127	126	137	136	.377
19	84	79	92	86	99	93	113	111	121	118	130	127	.420
20	80	74	87	81	94	88	107	103	114	111	123	120	.466
21	76	69	83	75	90	82	102	97	109	104	117	112	.513
22	72	65	79	71	86	77	97	92	104	98	112	106	.563
23	69	61	76	66	82	72	93	87	100	93	107	100	.616
24	66	57	72	63	79	68	89	82	95	88	103	94	.670
25	64	54	70	59	75	64	86	77	92	83	98	89	.727
26	61	51	67	56	73	61	82	73	88	78	95	84	.787
27	59	48	64	52	70	57	79	69	85	75	91	80	.848
28	57	45	62	50	67	54	76	66	82	71	88	76	.912
29	55	...	60	...	65	51	74	...	79	...	85	72	.979
30	53	...	58	...	63	...	71	...	76	...	82	...	1.047
31	51	...	56	...	61	...	69	...	74	...	79	...	1.118
32	50	...	54	...	59	...	67	...	72	...	77	...	1.192
33	48	...	53	...	57	...	65	...	69	...	75	...	1 267
34	47	...	51	...	55		63	...	67	...	72	...	1 345

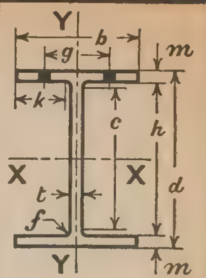
18" C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}''$ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".	18.000	*18.024	18.114	18.252
Wt. per foot.	47.0	51.0	52.0	58.0
Area	13.82	15.00	15.30	17.05
b"	7.500	7.555	7.534	7.573
t	.320	.375	.354	.393
h	$16\frac{7}{8}$	$16\frac{7}{8}$	$16\frac{7}{8}$	$16\frac{7}{8}$
m	.550	.562	.607	.676
k	$3\frac{1}{16}$	$3\frac{1}{16}$	$3\frac{1}{16}$	$3\frac{1}{16}$
f	.50	.50	.50	.50
c	$15\frac{7}{8}$	$15\frac{7}{8}$	$15\frac{7}{8}$	$15\frac{7}{8}$
g	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$
AXES X-X I	768.6	810.0	855.1	960.8
AXES X-X S	85.4	89.88	94.41	105.28
AXES X-X r	7.46	7.35	7.48	7.51
AXES Y-Y I	38.7	40.5	43.3	49.0
AXES Y-Y S	10.3	10.7	11.5	13.0
AXES Y-Y r	1.67	1.64	1.68	1.70
Coef. Str.	1024800	1078600	1133000	1263400
Max. Mom. "#	1537200	1617800	1699400	1895100
V	69100	81100	77000	86100
P. feet	7.41	6.65	7.36	7.34
R	30170	39020	35610	41950
W	36000	42190	39830	44220
Q. feet	14.23	12.78	14.22	14.28
w lbs.	25	25	25	25
Rivet dia.	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$

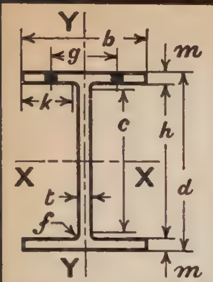
Live Load deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \text{Total Def.} \times \frac{\text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	138	138	162	162	154	154	172	172	
7	138	138	154	154	154	154	172	172	
8	128	128	135	135	142	142	158	158	.066
9	114	114	120	120	126	126	140	140	.084
10	102	101	108	106	113	112	126	125	.103
11	93	90	98	94	103	99	115	111	.125
12	85	80	90	85	94	89	105	99	.149
13	79	72	83	76	87	80	97	89	.175
14	73	65	77	69	81	72	90	80	.203
15	68	59	72	62	76	65	84	73	.233
16	64	54	67	57	71	59	79	67	.265
17	60	49	63	52	67	54	74	61	.299
18	57	45	60	47	63	49	70	55	.335
19	54	41	57	43	60	45	66	51	.373
20	51	38	54	40	57	42	63	47	.414
21	49	35	51	37	54	38	60	43	.456
22	47	32	49	34	52	35	57	40	.501
23	45	30	47	31	49	33	55	37	.548
24	43	27	45	29	47	30	53	34	.596
25	41	25	43	27	45	28	51	32	.647
26	39	...	41	...	44	...	49	...	.699
27	38	...	40	...	42	...	47	...	.754
28	37	...	39	...	40	...	45	...	.811
29	35	...	37	...	39	...	44	...	.870
30	34	...	36	...	38	...	42	...	.931
31	33	...	35	...	37	...	41	...	.994
32	32	...	34	...	35	...	39	...	1.06
33	31	...	33	...	34	...	38	...	1.13
34	30	...	32	...	33	...	37	...	1.20
35	29	...	31	...	32	...	36	...	1.27

* Special Section. Web Thickness $\frac{3}{8}''$



CARNEGIE BEAMS

18" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	18.000	18.110	18.242	18.000	18.120	18.238
Wt. per foot.	67.0	72.0	78.0	86.0	93.0	100.0
Area	19.69	21.17	22.94	25.29	27.35	29.40
b"	8.500	8.530	8.565	12.000	12.034	12.069
t	.406	.436	.471	.429	.463	.498
h	16½	16½	16½	16½	16½	16½
m	.745	.800	.866	.745	.805	.864
k	3⅜	3⅜	3⅜	5 1/16	5 1/16	5 1/16
f	.70	.70	.70	.70	.70	.70
c	15⅛	15⅛	15⅛	15⅛	15⅛	15⅛
g	5½	5½	5½	7½	7½	7½
AXES X-X I	1117.1	1208.1	1318.8	1514.1	1648.4	1783.4
AXES X-X S	124.12	133.42	144.59	168.23	181.94	195.57
AXES X-X r	7.53	7.55	7.58	7.74	7.76	7.79
AXES Y-Y I	76.4	82.9	90.9	214.7	234.0	253.4
AXES Y-Y S	18.0	19.4	21.2	35.8	38.9	42.0
AXES Y-Y r	1.97	1.98	1.99	2.91	2.93	2.94
Coef. Str.	1489500	1601000	1735100	2018800	2183300	2346800
Max. Mom."#	2234200	2401500	2602600	3028200	3275000	3520200
V	87700	94800	103100	92700	100700	109000
P. feet	8.49	8.45	8.41	10.89	10.84	10.77
R	44040	48930	54670	47760	53310	59040
W	91350	98100	105980	96530	104180	112050
Q. feet	8.15	8.16	8.18	10.46	10.48	10.47
w lbs.	41	41	41	41	41	41
Rivet dia.	⅞	⅞	⅞	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
6	175	175	190	190	206	206	185	185	201	201	218	218	
7	175	175	190	190	206	206	185	185	201	201	218	218	
8	175	175	190	190	206	206	185	185	201	201	218	218	
9	165	165	178	178	193	193	185	185	201	201	218	218	
10	149	149	160	160	174	174	185	185	201	201	218	218	
11	135	134	146	144	158	156	184	184	198	198	213	213	.125
12	124	120	133	130	145	141	168	168	182	182	196	196	.149
13	115	109	123	117	133	127	155	155	168	168	181	181	.175
14	106	99	114	106	124	116	144	144	156	156	168	168	.203
15	99	90	107	97	116	105	135	135	146	146	156	156	.233
16	93	83	100	89	108	96	126	124	136	134	147	144	.265
17	88	76	94	81	102	88	119	115	128	125	138	134	.299
18	83	69	89	75	96	81	112	107	121	116	130	125	.335
19	78	64	84	69	91	75	106	100	115	108	124	116	.373
20	74	59	80	64	87	69	101	93	109	101	117	109	.414
21	71	55	76	59	83	64	96	88	104	95	112	102	.456
22	68	51	73	55	79	60	92	82	99	89	107	96	.501
23	65	47	70	51	75	55	88	77	95	83	102	90	.548
24	62	44	67	47	72	51	84	73	91	78	98	85	.596
25	60	41	64	44	69	48	81	68	87	74	94	80	.647
26	57	38	62	41	67	45	78	64	84	70	90	75	.699
27	55	36	59	38	64	42	75	61	81	66	87	71	.754
28	53	33	57	36	62	39	72	58	78	62	84	67	.811
29	51	...	55	...	60	...	70	54	75	59	81	64	.870
30	50	...	53	...	58	...	67	52	73	56	78	60	.931
31	48	...	52	...	56	...	65	49	70	53	76	57	.994
32	47	...	50	...	54	...	63	46	68	50	73	54	1.06
33	45	...	49	...	53	...	61	...	66	...	71	...	1.13
34	44	...	47	...	51	...	59	...	64	...	69	...	1.20
35	43	...	46	...	50	...	58	...	62	...	67	...	1.27
36	41	...	44	...	48	...	56	...	61	...	65	...	1.34

21" C

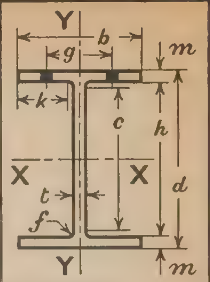
CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I. is Moment of Inertia S is Section Modulus
r is Radius of Gyration

V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}''$ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d".		21.000	*21.034	21.126	21.248
Wt. per foot.		58.0	60.0	64.0	70.0
Area		17.05	17.64	18.82	20.59
b"		8.000	8.015	8.036	8.073
t		.360	.375	.396	.433
h		19¾	19¾	19¾	19¾
m		.608	.625	.671	.732
k		3¼	3¼	3¼	3¼
f		.55	.55	.55	.55
c		18⅝	18⅝	18⅝	18⅝
g		4"	4"	4"	4"
AXES X-X	I	1263.2	1304.9	1403.3	1542.9
	S	120.30	124.08	132.85	145.23
	r	8.61	8.60	8.64	8.66
AXES Y-Y	I	52.0	53.7	58.3	64.3
	S	13.0	13.4	14.5	15.9
	r	1.75	1.75	1.76	1.77
Coef. Str.		1443600	1488900	1594200	1742700
Max. Mom. "#		2165500	2233400	2391300	2614100
V		90700	94700	100400	110400
P. feet		7.96	7.87	7.94	7.89
R		36180	38780	42460	49010
W		48600	50630	53460	58460
Q. feet		14.85	14.70	14.91	14.91
w lbs.		30	30	30	30
Rivet dia.		⅞	⅞	⅞	⅞

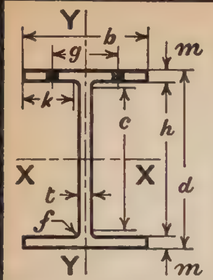
Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
7	181	181	189	189	201	201	221	221	
8	180	180	186	186	199	199	218	218	.057
9	160	160	165	165	177	177	194	194	.072
10	144	144	149	149	159	159	174	174	.089
11	131	128	135	132	145	142	158	156	.107
12	120	115	124	119	133	127	145	139	.123
13	111	104	115	107	123	115	134	126	.150
14	103	94	106	97	114	104	124	114	.174
15	96	85	99	88	106	94	116	103	.200
16	90	78	93	80	100	86	109	94	.227
17	85	71	88	73	94	79	103	86	.257
18	80	65	83	67	89	72	97	79	.287
19	76	60	78	62	84	67	92	73	320
20	72	55	74	57	80	61	87	67	.355
21	69	51	71	53	76	57	83	62	391
22	66	47	68	49	72	52	79	57	.429
23	63	44	65	45	69	49	76	53	.470
24	60	41	62	42	66	45	73	49	.511
25	58	38	60	39	64	42	70	46	.554
26	56	35	57	36	61	39	67	43	600
27	53	...	55	...	59	...	65	...	.646
28	52	...	53	...	57	...	62	...	.695
29	50	...	51	...	55	...	60	...	.746
30	48	...	50	...	53	...	58	...	.798
32	45	...	47	...	50	...	54	...	.908
34	42	...	44	...	47	...	51	...	1 03
36	40	...	41	...	44	...	48	...	1.15
38	38	...	39	...	42	...	46	...	1.28
40	36	...	37	...	40	...	44	...	1 42
42	34	...	35	...	38	...	41	...	1 56

* Special Section. Web Thickness ⅜"



CARNEGIE BEAMS

21" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	21.000	21.120	21.240	21.000	21.126	21.248
Wt. per foot.	80.0	86.0	92.0	104.0	112.0	120.0
Area	23.53	25.28	27.05	30.57	32.93	35.28
b"	9.000	9.032	9.064	13.000	13.034	13.070
t	.438	.470	.502	.465	.499	.535
h	19 5/16	19 5/16	19 5/16	19 5/16	19 5/16	19 5/16
m	.815	.875	.935	.815	.878	.939
k	3½	3½	3½	5½	5½	5½
f	.75	.75	.75	.75	.75	.75
c	17⅞	17⅞	17⅞	17⅞	17⅞	17⅞
g	5½	5½	5½	7½	7½	7½
AXES X-X I	1794.4	1939.3	2086.4	2475.3	2683.7	2890.9
AXES X-X S	170.90	183.65	196.46	235.74	254.07	272.11
AXES X-X r	8.73	8.76	8.78	9.00	9.03	9.05
AXES Y-Y I	99.2	107.7	116.3	298.7	324.3	349.7
AXES Y-Y S	22.0	23.8	25.7	45.9	49.8	53.5
AXES Y-Y r	2.05	2.06	2.07	3.13	3.14	3.15
Coef. Str.	2050700	2203700	2357500	2828900	3048800	3265300
Max.Mom."#	3076100	3305600	3536300	4243400	4573200	4898000
V	110400	119100	128000	117200	126500	136400
P. feet	9.29	9.25	9.21	12.07	12.05	11.97
R	49880	55580	61320	54660	60730	67190
W	59130	63450	67770	104630	112280	119300
Q. feet	17.34	17.37	17.39	13.52	13.58	13.69
w lbs.	30	30	30	41	41	41
Rivet dia.	⅞	⅞	⅞	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
7	221	221	238	238	256	256	234	234	253	253	273	273	
8	221	221	238	238	256	256	234	234	253	253	273	273	
9	221	221	238	238	256	256	234	234	253	253	273	273	
10	205	205	220	220	236	236	234	234	253	253	273	273	
11	186	186	200	200	214	214	234	234	253	253	273	273	
12	171	168	184	181	196	194	234	234	253	253	272	272	
13	158	153	170	164	181	175	218	218	235	235	251	251	.150
14	146	138	157	149	168	160	202	202	218	218	233	233	.174
15	137	127	147	136	157	146	189	189	203	203	218	218	.200
16	128	116	138	125	147	134	177	177	191	191	204	204	.227
17	121	106	130	115	139	123	166	164	179	178	192	191	.257
18	114	98	122	106	131	114	157	154	169	166	181	177	.287
19	108	91	116	98	124	105	149	143	160	155	172	166	.320
20	103	84	110	91	118	97	141	134	152	145	163	156	.355
21	98	78	105	84	112	90	135	126	145	136	155	146	.391
22	93	73	100	78	107	83	129	119	139	128	148	137	.429
23	89	67	96	73	103	78	123	111	133	120	142	129	.470
24	85	63	92	67	98	73	118	105	127	114	136	122	.511
25	82	59	88	63	94	68	113	99	122	107	131	115	.554
26	79	55	85	59	91	63	109	94	117	101	126	109	.600
27	76	51	82	55	87	59	105	89	113	96	121	103	.646
28	73	48	79	52	84	56	101	84	109	91	117	97	.695
29	71	45	76	48	81	52	98	80	105	86	113	92	.746
30	68	42	73	46	79	49	94	76	102	82	109	88	.798
32	64	...	69	...	74	...	88	68	95	74	102	79	.908
34	60	...	65	...	69	...	83	62	90	67	96	72	1.03
36	57	...	61	...	65	...	79	56	85	61	91	65	1.15
38	54	...	58	...	62	...	74	...	80	...	86	59	1.28
40	51	...	55	...	59	...	71	...	76	...	82	...	1.42
42	49	...	52	...	56	...	67	...	73	...	78	...	1.56

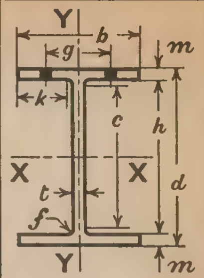
24" C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



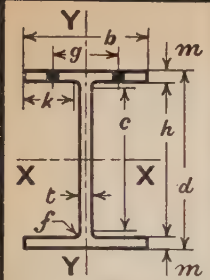
Depth = d".	24.000	24.000	24.154	24.308	
Wt. per foot.	70.0	76.0	85.0	94.0	
Area	20.58	22.35	24.99	27.64	
b"	8.500	9.750	9.797	9.844	
t	.400	.405	.452	.499	
h	22⅝	22⅝	22⅝	22⅝	
m	.663	.663	.740	.817	
k	3 7/16	4 1/16	4 1/16	4 1/16	
f	.60	.60	.60	.60	
c	21⅜	21⅜	21⅜	21⅜	
g	4"	5½	5½	5½	
AXES X-X I	1953.8	2184.4	2457.2	2734.9	
AXES X-X S	162.82	182.03	203.46	225.02	
AXES X-X r	9.74	9.89	9.92	9.95	
AXES Y-Y I	68.0	102.6	116.2	130.2	
AXES Y-Y S	16.0	21.0	23.7	26.4	
AXES Y-Y r	1.82	2.14	2.16	2.17	
Coef. Str.	1953800	2184400	2441500	2700200	
Max. Mom. "#	2930700	3276600	3662300	4050400	
V	115200	116600	131000	145600	
P. feet	8.48	9.36	9.32	9.27	
R	42750	43680	52580	61640	
W	54000	54680	61020	67370	
Q. feet	18.09	19.97	20.00	20.04	
w lbs.	30	30	30	30	
Rivet dia.	⅞	⅞	⅞	⅞	

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
8	230	230	233	233	262	262	291	291	
10	195	195	218	218	244	244	270	270	.078
12	163	158	182	182	203	203	225	225	.112
14	140	130	156	151	174	169	193	187	.152
16	122	108	137	127	153	142	169	158	.199
18	109	91	121	108	136	121	150	134	.251
20	98	78	109	93	122	104	135	115	.310
21	93	72	104	87	116	97	129	108	.342
22	89	67	99	81	111	90	123	100	.375
23	85	62	95	75	106	84	117	94	.411
24	81	57	91	70	102	79	113	88	.447
25	78	54	87	66	98	74	108	82	.485
26	75	50	84	62	94	69	104	77	.525
27	72	47	81	58	90	65	100	72	.566
28	70	44	78	54	87	61	96	68	.608
29	67	...	75	51	84	57	93	64	.653
30	65	...	73	48	81	54	90	60	.698
31	63	...	70	45	79	51	87	57	.746
32	61	...	68	43	76	48	84	53	.795
33	59	...	66	...	74	...	82	...	.845
34	57	...	64	...	72	...	79	...	.897
35	56	...	62	...	70	..	77	...	.950
36	54	...	61	...	68	...	75	...	1.01
38	51	...	57	...	64	...	71	...	1.12
40	49	...	55	...	61	...	68	...	1.24
42	47	...	52	...	58	...	64	...	1.37
44	44	...	50	...	55	...	61	...	1.50
46	42	...	47	...	53	...	59	...	1.64
48	41	...	46	...	51	...	56	...	1.79
50	39	...	44	...	49	...	54	...	1.94



CARNEGIE BEAMS

24" C

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia · S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

Depth = d".	24 000	24.156	24 310	24.250	24 388	24 526	24 664
Wt. per foot.	100 0	110 0	120 0	130 0	140 0	150 0	160 0
Area	29 41	32.34	35 29	38 23	41 16	44 10	47 06
b"	12 000	12 044	12.089	14.000	14.041	14 082	14 123
t	.450	494	.539	.547	.588	629	670
h	22⅜	22⅜	22⅜	22⅜	22⅜	22⅜	22⅜
m	.787	865	.942	.912	981	1 050	1 119
k	5"	5"	5"	5 15/16	5 15/16	5 15/16	5 15/16
f	80	80	.80	.80	.80	.80	.80
c	20¾	20¾	20¾	20¾	20¾	20¾	20¾
g	7½	7½	7½	10"	10"	10"	10"
AXES X-X I	3020.5	3343 5	3669.7	4045 1	4380 4	4720.5	5065 7
AXES X-X S	251.71	276.83	301.91	333.62	359.23	384.94	410.78
AXES X-X r	10.14	10.17	10.20	10.29	10.32	10 35	10.38
AXES Y-Y I	226.9	252.2	277.8	417.5	453.1	489.3	526.0
AXES Y-Y S	37.8	41.9	46.0	59.6	64.5	69.5	74.5
AXES Y-Y r	2.78	2.79	2.81	3.31	3.32	3.33	3.34
Coef. Str.	3020500	3321900	3622900	4003400	4310700	4619300	4929300
Max. Mom."#	4530700	4982900	5434300	6005100	6466100	6928900	7394000
V	129600	143200	157200	159200	172100	185100	198300
P. feet	11.65	11 60	11 52	12 57	12 52	12 47	12 43
R	52200	60650	69400	70920	78940	87000	95100
W	121500	133380	143160	143160	143160	143160	143160
Q. feet	12 43	12 45	12 65	13 98	15 06	16 13	17 22
w lbs.	49	49	49	49	49	49	49
Rivet dia	1"	1"	1"	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

$$\text{Live Load Def.} = \frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
8	259	259	286	286	314	314	318	318	344	344	370	370	397	397	
10	259	259	286	286	314	314	318	318	344	344	370	370	397	397	
12	252	252	277	277	302	302	318	318	344	344	370	370	397	397	
14	216	216	237	237	259	259	286	286	308	308	330	330	352	352	152
16	189	186	208	205	226	223	250	250	269	269	289	289	308	308	.199
18	168	160	185	176	201	193	222	221	239	238	257	255	274	273	.251
20	151	140	166	154	181	168	200	194	216	209	231	224	246	239	310
21	144	131	158	144	173	158	191	182	205	196	220	210	235	225	.342
22	137	123	151	135	165	148	182	172	196	185	210	198	224	212	375
23	131	115	144	127	158	139	174	162	187	174	201	188	214	200	.411
24	126	109	138	119	151	131	167	153	180	165	192	177	205	189	.447
25	121	102	133	112	145	123	160	145	172	156	185	167	197	179	.485
26	116	96	128	106	139	116	154	137	166	148	178	158	190	170	.525
27	112	91	123	100	134	110	148	130	160	140	171	150	183	160	.566
28	108	86	119	95	129	104	143	123	154	133	165	143	176	153	.608
29	104	81	115	90	125	98	138	117	149	126	159	135	170	145	653
30	101	77	111	85	121	93	133	111	144	121	154	129	164	138	698
31	97	73	107	80	117	88	129	106	139	114	149	123	159	131	.746
32	94	69	104	75	113	84	125	101	135	109	144	117	154	125	795
33	92	66	101	71	110	79	121	96	131	104	140	112	149	119	845
34	89	63	98	68	107	75	118	92	127	99	136	106	145	113	.897
35	86	59	95	64	104	72	114	88	123	94	132	102	141	108	.950
36	84	57	92	61	101	68	111	84	120	90	128	97	137	104	1 01
38	79	51	87	55	95	62	105	77	113	82	122	88	130	95	1.12
40	76	47	83	...	91	56	100	70	108	75	115	80	123	87	1.24
42	72	..	79	...	86	...	95	64	103	69	110	75	117	80	1 37
44	69	...	75	...	82	...	91	...	98	...	105	..	112	73	1 50
46	66	...	72	...	79	...	87	...	94	...	100	...	107	...	1.64
48	63	...	69	...	75	...	83	...	90	...	96	...	103	...	1 79
50	60	...	66	...	72	...	80	..	86	...	92	...	99	...	1 94

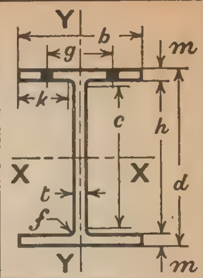
27" C

CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



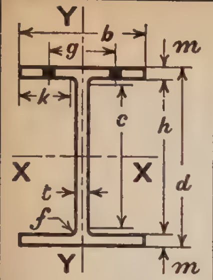
Depth = d".	27.000	27.166	27.340	27.536	27.742	27.000	27.200	27.400	27.598
Wt. per foot.	91.0	101.0	112.0	124.0	137.0	145.0	160.0	175.0	190.0
Area	26.76	29.70	32.94	36.47	40 29	42.64	47.04	51.47	55.87
b"	9.750	9.799	9.855	9.913	9.977	14.000	14.059	14.118	14.176
t	.461	.510	.566	624	.688	.580	.639	.698	.756
h	25 7/16	25 7/16	25 7/16	25 7/16	25 7/16	25"	25"	25"	25"
m	.755	.838	.925	1.023	1.126	.985	1.085	1.185	1.284
k	4"	4"	4"	4"	4"	4"	4"	4"	4"
f	.65	.65	.65	.65	.65	.90	.90	.90	.90
c	24⅛	24⅛	24⅛	24⅛	24⅛	23¼	23¼	23¼	23¼
g	5½	5½	5½	5½	5½	10"	10"	10"	10"
AXES X-X I	3217.0	3595.7	4007.6	4472.1	4975.9	5508.7	6121.8	6746.8	7376.9
AXES X-X S	238.30	264.72	293.17	324.82	358.73	408.05	450.13	492.47	534.60
AXES X-X r	10.97	11.00	11.03	11.07	11.11	11.37	11.41	11.45	11.49
AXES Y-Y I	116.9	131.7	148.0	166.7	187.1	451.0	503.2	556.6	610.7
AXES Y-Y S	24.0	26.9	30.0	33.6	37.5	64.4	71.6	78.9	86.2
AXES Y-Y r	2.09	2.11	2.12	2.14	2.16	3.25	3.27	3.29	3.31
Coef. Str.	2859500	3176600	3518000	3897800	4304700	4896600	5401600	5909600	6415200
Max. Mom. "#	4289300	4765000	5277000	5846700	6457100	7344900	8102400	8864400	9622700
V	149400	166300	185700	206200	229000	187900	208600	229500	250400
P. feet	9.57	9.55	9.47	9.45	9 40	13.03	12.95	12 88	12.81
R	54120	64140	75810	88050	101660	78620	90990	103470	115800
W	82980	91800	95440	95440	95440	167020	167020	167020	167020
Q. feet	17.23	17 30	18.43	20.42	22.55	14.66	16 17	17 69	19.20
w lbs.	40	40	40	40	40	58	58	58	58
Rivet dia.	1"	1"	1"	1"	1"	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
8	299	299	333	333	371	371	412	412	458	458	376	376	417	417	459	459	501	501	
10	286	286	318	318	352	352	390	390	423	423	376	376	417	417	459	459	501	501	
12	238	238	265	265	293	293	325	325	352	352	376	376	417	417	459	459	501	501	
14	204	198	227	219	251	244	278	270	302	294	350	350	386	386	422	422	458	458	.135
16	179	166	199	185	220	206	244	228	264	248	306	306	338	338	369	369	401	401	.177
18	159	141	176	158	195	175	217	197	235	211	272	270	300	299	328	327	356	355	.223
20	143	122	159	136	176	151	195	167	211	182	245	237	270	262	295	287	321	311	.276
21	136	114	151	126	168	140	186	156	201	170	233	223	257	246	281	270	305	293	.304
22	130	106	144	118	160	131	177	145	192	158	223	210	246	232	269	254	292	277	.334
23	124	99	138	110	153	122	169	136	184	147	213	198	235	218	257	240	279	260	.365
24	119	92	132	102	147	114	162	127	176	138	204	187	225	207	246	226	267	246	.397
25	114	86	127	96	141	107	156	119	169	130	196	177	216	196	236	214	257	233	.431
26	110	81	122	90	135	100	150	111	163	121	188	168	208	185	227	203	247	221	.466
27	106	76	118	85	130	94	144	104	157	114	181	159	200	176	219	192	238	210	.503
28	102	71	113	79	126	88	139	98	151	107	175	151	193	166	211	183	229	199	.540
29	99	67	110	75	121	83	134	93	146	100	169	144	186	158	204	173	221	189	.580
30	95	63	106	70	117	78	130	87	141	95	163	136	180	151	197	165	214	179	.621
31	92	59	102	66	113	74	126	82	136	89	158	130	174	143	191	158	207	171	.662
32	89	56	99	62	110	69	122	77	132	84	153	123	169	137	185	150	200	163	.706
33	87	...	96	...	107	...	118	73	128	79	148	118	164	130	179	143	194	155	.751
34	84	...	93	...	103	...	115	...	124	...	144	112	159	124	174	136	189	148	.797
35	82	...	91	...	101	...	111	...	121	..	140	107	154	119	169	130	183	141	.844
36	79	...	88	...	98	...	108	...	117	...	136	103	150	113	164	124	178	135	.894
38	75	...	84	...	93	...	103	...	111	...	129	94	142	103	156	114	169	123	.996
40	71	...	79	...	88	...	97	...	106	...	122	86	135	95	148	104	160	114	1.10
42	68	...	76	...	84	...	93	..	101	...	117	79	129	87	141	95	153	104	1.22
44	65	...	72	...	80	...	89	...	96	...	111	72	123	80	134	88	146	96	1.34
46	62	...	69	...	76	...	85	...	92	...	106	66	117	74	128	81	139	88	1.46
48	60	...	66	...	73	...	81	...	88	...	102	...	113	...	123	...	134	...	1.59
50	57	...	64	...	70	...	78	...	85	...	98	...	108	...	118	...	128	...	1.72



CARNEGIE BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

30" C

Depth = d".	30.000	30.162	30.344	30.538	30.742	30.000	30.263	30.522	30.781
Wt. per foot.	115.0	126.0	138.0	151.0	165.0	180.0	200.0	220.0	240.0
Area	33.81	37.05	40.58	44.41	48 52	52.93	58.82	64.70	70.58
b"	10.500	10.551	10.604	10.662	10.725	14.000	14.073	14.146	14.218
t	.530	.581	.634	.692	.755	.670	.743	.816	.888
h	28 3/16	28 3/16	28 3/16	28 3/16	28 3/16	27 9/16	27 9/16	27 9/16	27 9/16
m	.882	.963	1.054	1.151	1.253	1.207	1.338	1.468	1.597
k	4 5/16	4 5/16	4 5/16	4 5/16	4 5/16	5 11/16	5 11/16	5 11/16	5 11/16
f	.70	.70	.70	.70	.70	1.00	1.00	1.00	1.00
c	26¾	26¾	26¾	26¾	26¾	25½	25½	25½	25½
g	5½	5½	5½	5½	5½	10"	10"	10"	10"
AXES X-X I	4985.3	5486.7	6049.5	6663.7	7326.7	8301.4	9305.7	10320.4	11356.0
AXES X-X S	332.35	363.82	398.73	436.42	476.66	553.43	614.99	676.26	737.86
AXES X-X r	12.14	12.17	12.21	12.25	12.29	12.52	12.58	12.63	12.69
AXES Y-Y I	170.6	189.0	210.1	233.4	258.7	552.7	622.7	693.9	766.9
AXES Y-Y S	32.5	35.8	39.6	43.8	48.2	79.0	88.5	98.1	107.9
AXES Y-Y r	2.25	2.26	2.28	2.29	2.31	3.23	3.25	3.28	3.30
Coef. Str.	3988200	4365800	4784700	5237000	5719900	6641100	7379900	8115100	8854300
Max. Mom. "#	5982400	6548700	7177100	7855600	8579900	9961700	11069800	12172700	13281400
V	190800	210300	230900	253600	278500	241200	269800	298900	328000
P. feet	10.45	10.38	10.36	10.33	10.27	13.77	13.68	13.58	13.50
R	68410	79670	91550	104700	119090	99440	115940	132570	149090
W	107330	107370	107370	107370	107370	190880	190880	190880	190880
Q. feet	18.58	20.33	22.28	24.38	26.64	17.40	19.33	21.26	23.19
w lbs.	45	45	45	45	45	66	66	66	66
Rivet dia.	1"	1"	1"	1"	1"	1"	1"	1"	1"

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
10	382	382	421	421	462	462	507	507	557	557	482	482	540	540	598	598	656	656	
12	332	332	364	364	399	399	436	436	477	477	482	482	540	540	598	598	656	656	
14	285	281	312	307	342	338	374	370	409	404	474	474	527	527	580	580	632	632	.122
16	249	237	273	260	299	286	327	313	358	342	415	415	461	461	507	507	553	553	.159
18	222	203	243	223	266	245	291	268	318	293	369	366	410	408	451	449	492	490	.201
20	199	176	218	193	239	211	262	232	286	254	332	321	369	358	406	394	443	430	.248
21	190	164	208	179	228	197	249	216	272	237	316	302	351	336	386	371	422	405	.274
22	181	153	198	168	217	184	238	202	260	222	302	285	335	317	369	349	402	382	.300
23	173	143	190	157	208	173	228	189	249	208	289	268	321	300	353	329	385	359	.329
24	166	134	182	147	199	162	218	178	238	195	277	254	307	282	338	312	369	340	.358
25	160	126	175	138	191	152	209	166	229	183	266	240	295	268	325	294	354	322	.388
26	153	118	168	130	184	142	201	157	220	172	255	227	284	253	312	279	341	305	.420
27	148	111	162	122	177	134	194	147	212	162	246	215	273	240	301	264	328	289	.452
28	142	105	156	115	171	126	187	139	204	153	237	205	264	227	290	251	316	274	.487
29	138	98	151	108	165	119	181	131	197	143	229	195	254	216	280	239	305	261	.522
30	133	93	145	102	159	112	175	124	191	136	221	185	246	206	271	227	295	249	.559
31	129	88	141	97	154	106	169	116	185	128	214	176	238	196	262	216	286	236	.596
32	125	83	136	91	150	100	164	110	179	121	208	167	231	187	254	205	277	225	.636
33	121	78	132	86	145	95	159	104	173	114	201	160	224	178	246	196	268	215	.676
34	117	74	128	81	141	90	154	99	168	109	195	152	217	170	239	188	260	205	.718
35	114	70	125	77	137	85	150	93	163	103	190	145	211	162	232	179	253	196	.760
36	111	...	121	...	133	...	145	...	159	...	184	139	205	155	225	171	246	187	.804
38	105	...	115	...	126	...	138	...	151	...	175	127	194	141	214	156	233	171	.896
40	100	...	109	...	120	...	131	...	143	...	166	116	184	130	203	143	221	157	.993
42	95	...	104	...	114	..	125	...	136	...	158	107	176	119	193	131	211	144	1.10
44	91	...	99	...	109	...	119	...	130	...	151	98	168	109	184	121	201	132	1.20
46	87	...	95	...	104	...	114	...	124	...	144	90	160	101	176	111	192	122	1.31
48	83	...	91	...	100	...	109	...	119	...	138	...	154	...	169	..	184	...	1.43
50	80	...	87	...	96	...	105	...	114	...	133	...	148	...	162	...	177	...	1.55
52	77	...	84	...	92	...	101	...	110		128	...	142	...	156	...	170	...	1.68

ALLOWABLE END REACTIONS FOR CARNEGIE BEAMS
DETERMINED BY
BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight per Foot	Web t	Unit Stress in Buckling	Reaction R for 3½″ Bearing	Min. Span for 3½″ Bearing	Reaction R for 5½″ Bearing	Increase in R for 1″ Additional Bearing	Max. Web Shear V.	Length of Bearing to develop V.
8	24.0	.239″	15000	19720	6.41	26890	3590	22900	4.40″
	27.0	.268	15000	22210	6.40	30250	4020	26000	4.45
	30.0	.298	15000	24800	6.37	33740	4470	29300	4.51
	31.0	.290	15000	23990	6.88	32690	4350	28100	4.43
	36.0	.336	15000	27970	6.87	38050	5040	33100	4.51
	42.0	.390	15000	32700	6.86	44400	5850	39100	4.60
9	29.0	.279	15000	24060	6.98	32430	4190	30100	4.95
	32.0	.307	15000	26590	6.97	35800	4610	33500	5.00
	35.0	.335	15000	29130	6.96	39180	5030	37000	5.06
	38.0	.316	15000	27250	8.34	36730	4740	34100	4.95
	43.0	.357	15000	30950	8.31	41660	5360	39100	5.02
	48.0	.398	15000	34690	8.28	46630	5970	44100	5.08
10	21.0	.230	13750	18900	6.90	25220	3160	27300	6.17
	23.0	.230	13690	18890	7.76	25190	3150	27600	6.27
	26.0	.259	14360	22410	7.40	29850	3720	31400	5.91
	30.0	.298	15000	27070	7.07	36010	4470	36600	5.63
	31.0	.320	15000	28800	6.81	38400	4800	38400	5.50
	36.0	.467	15000	42030	5.01	56040	7010	56000	5.50
	42.0	.644	15000	57960	3.94	77280	9660	77300	5.50
	49.0	.375	15000	33750	9.46	45000	5630	45000	5.50
	56.0	.581	15000	52290	6.50	69720	8720	69700	5.50
	63.0	.787	15000	70830	5.09	94450	11810	94400	5.50
12	25.0	.240	12750	19840	9.28	25960	3060	34300	8.24
	28.0	.240	12710	19820	10.77	25920	3050	34600	8.33
	32.0	.274	13580	24290	10.04	31730	3720	39800	7.68
	* 34.0	.375	15000	36590	6.50	47840	5630	54100	6.61
	36.0	.308	14250	28790	9.54	37570	4390	45200	7.24
	40.0	.290	14000	26400	11.88	34520	4060	41800	7.28
	45.0	.326	14630	31140	11.34	40680	4770	47500	6.92
	50.0	.361	15000	35550	11.03	46380	5420	53100	6.74
	55.0	.375	15000	36560	11.72	47810	5630	54000	6.60
	60.0	.497	15000	48460	9.20	63370	7460	71600	6.60
	65.0	.620	15000	60450	7.67	79050	9300	89300	6.60
	70.0	.742	15000	72350	6.65	96050	11300	106900	6.46
	75.0	.486	15000	47380	12.21	61970	7290	70000	6.60
	83.0	.682	15000	66500	9.12	86960	10230	98200	6.60
	91.0	.878	15000	85610	7.42	111950	13170	126400	6.60
	100.0	1.098	15000	107060	6.23	140000	16470	158100	6.60
14	30.0	.270	12450	23500	10.68	30220	3360	45200	9.97
	33.0	.270	12430	23490	12.17	30200	3360	45400	10.02
	36.0	.294	13020	26880	11.59	34540	3830	49700	9.46
	* 38.0	.375	14610	38340	7.99	49300	5480	63000	8.00
	39.0	.318	13530	30290	11.14	38890	4300	54000	9.02
	42.0	.342	13970	33720	10.78	43280	4780	58400	8.68
	48.0	.343	14090	33820	11.57	43480	4830	57600	8.43
	53.0	.378	14600	38810	12.10	49850	5520	64100	8.07
	58.0	.413	15000	43740	11.74	56130	6200	70600	7.83
	61.0	.382	14670	39360	14.20	50560	5600	64600	8.01
	68.0	.425	15000	45000	13.84	57750	6380	72600	7.83
	75.0	.468	15000	49810	13.79	63850	7020	80800	7.91
	85.0	.435	15000	45670	17.29	58720	6530	73100	7.70
	95.0	.485	15000	51260	17.23	65810	7280	82600	7.80
	105.0	.536	15000	57020	17.13	73100	8040	92400	7.90

The beam web is treated as a column with fixed ends, having an effective length of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.

When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

* Special Section. Web Thickness ⅜″.

ALLOWABLE END REACTIONS FOR CARNEGIE BEAMS

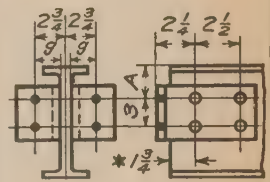
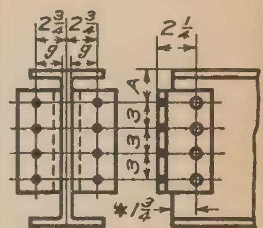
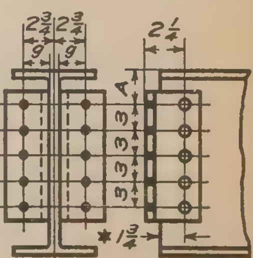
DETERMINED BY

BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight per foot	Web t	Unit Stress in Buckling	Reaction R for 3½" Bearing	Min. Span for 3½" Bearing	Reaction R for 5½" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V.	Length of Bearing to develop V.
16	35.0	.290	11980	25990	12.62	32930	3470	55400	11.98
	38.0	.314	12560	29590	12.03	37470	3940	60300	11.30
	40.0	.290	11940	25970	15.15	32890	3460	55700	12.08
	43.0	.375	13840	38830	10.16	49210	5190	71700	9.84
	45.0	.326	12790	31390	14.10	39730	4170	63100	11.11
	50.0	.362	13470	36890	13.33	46650	4880	70600	10.41
	58.0	.375	13810	38840	15.00	49200	5180	72000	9.90
	63.0	.406	14260	43580	14.52	55160	5790	78500	9.54
	68.0	.438	14650	48480	14.09	61320	6420	85300	9.24
	76.0	.419	14480	45510	17.49	57650	6070	80500	9.26
	83.0	.458	14920	51450	16.90	65110	6830	88600	8.94
	90.0	.495	15000	56130	16.79	70990	7430	96500	8.93
	100.0	.464	15000	52200	20.50	66120	6960	89100	8.80
	107.0	.496	15000	56000	20.45	70880	7440	95900	8.86
	115.0	.532	15000	60320	20.41	76280	7980	103700	8.93
18	47.0	.320	11790	30170	16.98	37710	3770	69100	13.83
	51.0	.375	13000	39020	13.82	48780	4880	81100	12.14
	52.0	.354	12530	35610	15.91	44490	4440	77000	12.82
	58.0	.393	13240	41950	15.06	52350	5200	86100	11.98
	67.0	.406	13560	44040	16.91	55060	5510	87700	11.43
	72.0	.436	13980	48930	16.36	61130	6100	94800	11.02
	78.0	.471	14400	54670	15.87	68230	6780	103100	10.64
	86.0	.429	13920	47760	21.13	59700	5970	92700	11.02
	93.0	.463	14340	53310	20.48	66590	6640	100700	10.63
	100.0	.498	14710	59040	19.88	73700	7330	109800	10.32
21	58.0	.360	11490	36180	19.95	44460	4140	90700	16.69
	60.0	.375	11810	38780	19.20	47640	4430	94700	16.12
	64.0	.396	12210	42460	18.77	52140	4840	100400	15.48
	70.0	.433	12850	49010	17.78	60130	5560	110400	14.54
	80.0	.438	13010	49880	18.45	61280	5700	110400	14.11
	86.0	.470	13470	55580	19.83	68240	6330	119100	13.54
	92.0	.502	13860	61320	19.22	75240	6960	128000	13.07
	104.0	.465	13430	54660	25.88	67140	6240	117200	13.51
	112.0	.499	13860	60730	25.10	74570	6920	126500	13.01
	120.0	.535	14250	67190	24.30	82430	7620	136400	12.58
24	70.0	.400	11250	42750	22.85	51750	4500	115200	19.60
	76.0	.405	11350	43680	25.00	52880	4600	116600	19.37
	85.0	.452	12200	52580	23.22	63600	5510	131000	17.73
	94.0	.499	12900	61640	21.90	74520	6440	145600	16.54
	100.0	.450	12210	52200	28.93	63180	5490	129600	17.59
	110.0	.494	12870	60650	27.39	73370	6360	143200	16.48
	120.0	.539	13440	69400	26.10	83880	7240	157200	15.62
	130.0	.547	13560	70920	28.23	85760	7420	159200	15.40
	140.0	.588	13990	78940	27.30	95400	8230	172100	14.82
	150.0	.629	14360	87000	26.55	105600	9030	185100	14.36
	160.0	.670	14680	95100	25.92	114780	9840	198300	13.99
27	91.0	.461	11450	54120	26.42	64680	5280	149400	21.54
	101.0	.510	12220	64140	24.76	76600	6230	166300	19.88
	112.0	.566	12960	75810	23.20	90490	7340	185700	18.48
	124.0	.624	13588	88050	22.14	105000	8480	206200	17.43
	137.0	.688	14160	101660	21.17	121150	9740	229000	16.57
	145.0	.580	13220	78620	31.14	93960	7670	187900	17.75
	160.0	.639	13830	90990	29.68	108670	8840	208600	16.81
	175.0	.698	14320	103470	28 56	123470	10000	229500	16.11
	190.0	.756	14730	115800	27.70	138080	11140	250400	15.59
30	115.0	.530	11730	68410	29.15	80850	6220	190800	23.18
	126.0	.581	12420	79670	27.40	94100	7220	210300	21.60
	138.0	.634	13030	91550	26.13	108060	8260	230900	20.37
	151.0	.692	13590	104700	25.01	123500	9400	253600	19.34
	165.0	.755	14100	119090	24.01	140390	10650	278500	18.47
	180.0	.670	13490	99440	33.39	117520	9040	241200	19.18
	200.0	.743	14100	115940	31.83	136900	10480	269800	18.19
	220.0	.816	14600	132570	30.61	156390	11910	298900	17.46
	240.0	.888	15000	149090	29.69	175730	13320	328000	16.93

CONNECTION ANGLES FOR CARNEGIE BEAMS

DIMENSIONS, WEIGHTS AND WORKING LOADS — 3/4" POWER DRIVEN RIVETS

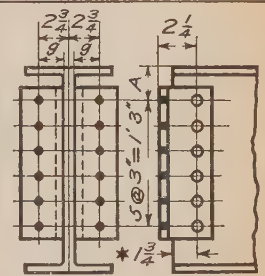
Beam		Connection Value			Framing Distance	Connection Angles				Connection Details.
			Outstanding Single Shear							
Depth	Weight per foot	Web	Power Driven Rivets	Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	
8"	24.0	21510	23860	17670	3/16	IC.13.10	2 5/8	6" × 4" × 3/8" 0' — 5½" Long	13 lbs.	
	27.0	24120	23860	17670	3/16	IC.13.10	2 5/8			
	30.0	26820	23860	17670	3/16	IC.13.10	2 5/8			
9"	29.0	25110	23860	17670	3/16	IC.13.10	2 5/8			
	32.0	27630	23860	17670	3/16	IC.13.10	2 5/8			
	35.0	30150	23860	17670	1/4	IC.13. 9	2 9/16			
10"	21.0	20700	23860	17670	3/16	IC.13.10	2 5/8			
	23.0	20700	23860	17670	3/16	IC.13.10	2 5/8			
	26.0	23310	23860	17670	3/16	IC.13.10	2 5/8			
	30.0	26820	23860	17670	3/16	IC.13.10	2 5/8			
12"	25.0	21600	23860	17670	3/16	IC.13.10	2 5/8			
	28.0	21600	23860	17670	3/16	IC.13.10	2 5/8			
	32.0	24660	23860	17670	3/16	IC.13.10	2 5/8			
	34.0	33750	23860	17670	1/4	IC.13. 9	2 9/16			
	36.0	27720	23860	17670	3/16	IC.13.10	2 5/8			
	40.0	26120	23860	17670	3/16	IC.13.10	2 5/8			
	45.0	29340	23860	17670	1/4	IC.13. 9	2 9/16			
	50.0	32490	23860	17670	1/4	IC.13. 9	2 9/16			
14"	30.0	24300	47720	35340	3/16	IC.19.10	2 5/8*	4" × 3½" × 3/8" 0' — 11½" Long	19 lbs.	
	33.0	24300	47720	35340	3/16	IC.19.10	2 5/8			
	36.0	26460	47720	35340	3/16	IC.19.10	2 5/8			
	38.0	33750	47720	35340	1/4	IC.19. 9	2 9/16			
	39.0	28620	47720	35340	1/4	IC.19. 9	2 9/16			
	42.0	30780	47720	35340	1/4	IC.19. 9	2 9/16			
16"	35.0	26100	47720	35340	3/16	IC.19.10	2 5/8			
	38.0	28260	47720	35340	1/4	IC.19.10	2 5/8			
	40.0	26100	47720	35340	3/16	IC.19.10	2 5/8			
	43.0	33750	47720	35340	1/4	IC.19. 9	2 9/16			
	45.0	29340	47720	35340	1/4	IC.19. 9	2 9/16			
	50.0	32580	47720	35340	1/4	IC.19. 9	2 9/16			
18"	47.0	36000	59650	44180	1/4	IC.25. 9	2 9/16	4" × 3½" × 3/8" 1' — 2½" Long	25 lbs.	
	51.0	42190	59650	44180	1/4	IC.25. 9	2 9/16			
	52.0	39830	59650	44180	1/4	IC.25. 9	2 9/16			
	58.0	44220	59650	44180	1/4	IC.25. 9	2 9/16			

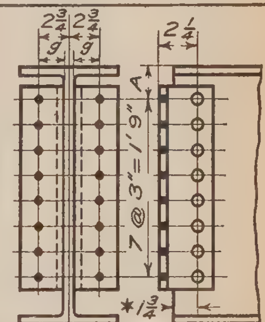
*Layer-out starts with this dimension at left end of beam. With beams ordered one inch short, as usual in standard shop practice, this leaves sufficient end distance or clearance at right end, in case of full allowable 3/8" underrun or 3/8" overrun in beam lengths.

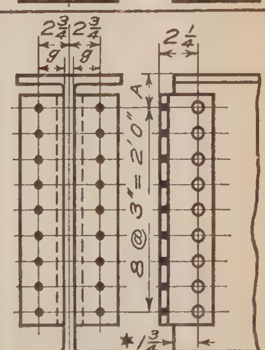
CONNECTION ANGLES FOR CARNEGIE BEAMS

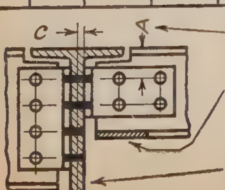
DIMENSIONS, WEIGHTS AND WORKING LOADS — **3/4" POWER DRIVEN RIVETS**

Beam		Connection Value			Framing Distance	Connection Angles				Connection Details.
			Outstanding Single Shear							
Depth	Weight per foot	Web	Power Driven Rivets	Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	
21"	58.0	48600	71580	53020	1/4	IC.30. 9	2 9/16	4" × 3½" × 3/8" 1' — 5½" Long	30 lbs.	
	60.0	50630	71580	53020	1/4	IC.30. 9	2 9/16			
	64.0	53460	71580	53020	1/4	IC.30. 9	2 9/16			
	70.0	58460	71580	53020	1/4	IC.30. 9	2 9/16			
	80.0	59130	71580	53020	5/16	IC.30. 8	2 ½			
	86.0	63450	71580	53020	5/16	IC.30. 8	2 ½			
	92.0	67770	71580	53020	3/8	IC.30. 8	2 ½			
24"	70.0	54000	71580	53020	1/4	IC.30. 9	2 9/16			
	76.0	54680	71580	53020	1/4	IC.30. 9	2 9/16			
	85.0	61020	71580	53020	5/16	IC.30. 8	2 ½			
	94.0	67370	71580	53020	5/16	IC.30. 8	2 ½			
27"	91.0	82980	95440	70690	5/16	IC.40. 8	2 ½	4" × 3½" × 3/8" 1' — 11½" Long	40 lbs.	
	101.0	91800	95440	70690	5/16	IC.40. 8	2 ½			
	112 0	95440	95440	70690	3/8	IC.40. 8	2 ½			
	124.0	95440	95440	70690	3/8	IC.40. 7	2 7/16			
	137.0	95440	95440	70690	7/16	IC.40. 6	2 3/8			
30"	115.0	107330	107370	79530	5/16	IC.45. 8	2 ½	4" × 3½" × 3/8" 2' — 2½" Long	45 lbs.	
	126.0	107370	107370	79530	5/16	IC.45. 7	2 7/16			
	138.0	107370	107370	79530	5/16	IC.45. 7	2 7/16			
	151.0	107370	107370	79530	3/8	IC.45. 6	2 3/8			
	165.0	107370	107370	79530	3/8	IC.45. 6	2 3/8			









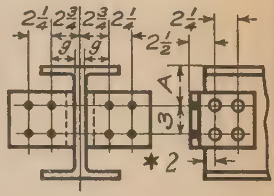
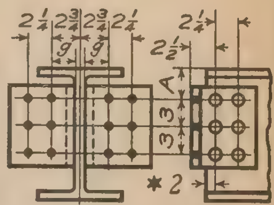
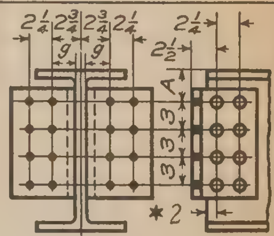
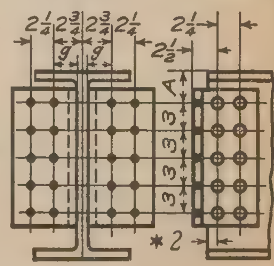
When A = 3" all beams can be framed opposite with tops flush.

Flange must be cut away as shown for field riveting on all beams framing opposite a larger beam, if flange interferes with outstanding rivets.

Minimum Web required to develop Single Shearing Value is .33"
Minimum Web required to develop Double Shearing Value is .53"

CONNECTION ANGLES FOR CARNEGIE BEAMS

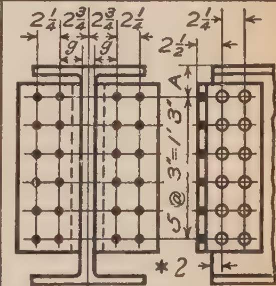
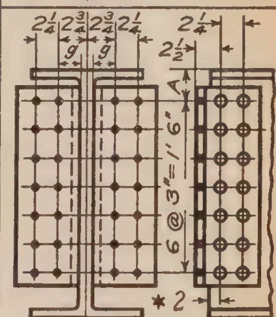
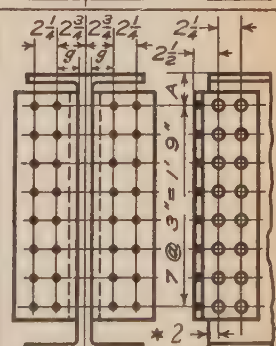
DIMENSIONS, WEIGHTS AND WORKING LOADS — 3/4" POWER DRIVEN RIVETS

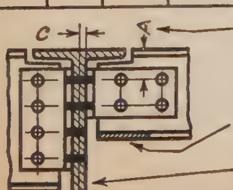
Beam Depth	Beam Weight per foot	Connection Value Web	Connection Value Outstanding Single Shear Power Driven Rivets	Connection Value Outstanding Single Shear Unfinished Bolts	Framing Distance C	Connection Angles A.I.S.C. Mark	Connection Angles Gage g	Connection Angles Size and Length	Connection Angles Weight inc. Web Rivets	Connection Details
8"	31.0	26100	47720	35340	3/16	IC.16.10	2 5/8	6" × 6" × 3/8" 0' — 5½" Long	16 lbs.	
	36.0	30240	47720	35340	1/4	IC.16. 9	2 9/16			
	42.0	35100	47720	35340	1/4	IC.16. 9	2 9/16			
9"	38.0	28440	47720	35340	1/4	IC.16. 9	2 9/16			
	43.0	32130	47720	35340	1/4	IC.16. 9	2 9/16			
	48.0	35820	47720	35340	1/4	IC.16. 9	2 9/16			
10"	31.0	28800	47720	35340	1/4	IC.16. 9	2 9/16			
	36.0	42030	47720	35340	5/16	IC.16. 8	2 1/2			
	42.0	47720	47720	35340	3/8	IC.16. 7	2 7/16			
	49.0	33750	47720	35340	1/4	IC.16. 9	2 9/16			
	56.0	47720	47720	35340	3/8	IC.16. 7	2 7/16			
	63.0	47720	47720	35340	7/16	IC.16. 6	2 3/8			
12"	55.0	50630	71580	53020	1/4	IC.24. 9	2 9/16	6" × 6" × 3/8" 0' — 8½" Long	24 lbs.	
	60 0	67100	71580	53020	5/16	IC.24. 8	2 1/2			
	65.0	71580	71580	53020	3/8	IC.24. 7	2 7/16			
	70.0	71580	71580	53020	7/16	IC.24. 6	2 3/8			
	75.0	65610	71580	53020	5/16	IC.24. 8	2 1/2			
	83.0	71580	71580	53020	3/8	IC.24. 7	2 7/16			
	91.0	71580	71580	53020	1/2	IC.24. 5	2 5/16			
	100.0	71580	71580	53020	5/8	IC.24. 3	2 3/16			
14"	48.0	46300	71580	53020	1/4	IC.24. 9	2 9/16			
	53.0	51030	71580	53020	1/4	IC.24. 9	2 9/16			
	58.0	55760	71580	53020	1/4	IC.24.10	2·5/8			
	61 0	51570	71580	53020	1/4	IC.24. 9	2 9/16			
	68.0	57370	71580	53020	1/4	IC.24. 9	2 9/16			
	75.0	63180	71580	53020	5/16	IC.24. 8	2 1/2			
	85.0	58730	71580	53020	1/4	IC.24. 9	2 9/16			
	95.0	65470	71580	53020	5/16	IC.24. 8	2 1/2			
	105.0	71580	71580	53020	5/16	IC.24. 8	2 1/2			
16"	58.0	67500	95440	70690	1/4	IC.33. 9	2 9/16	6" × 6" × 3/8" 0' — 11½" Long	33 lbs.	
	63.0	73080	95440	70690	1/4	IC.33. 9	2 9/16			
	68.0	78840	95440	70690	5/16	IC.33. 9	2 9/16			
	76.0	75420	95440	70690	1/4	IC.33. 9	2 9/16			
	83.0	82440	95440	70690	5/16	IC.33. 8	2 1/2			
	90.0	89100	95440	70690	5/16	IC.33. 8	2 1/2			
	100.0	83520	95440	70690	5/16	IC.33. 8	2 1/2			
	107.0	89280	95440	70690	5/16	IC.33. 8	2 1/2			
	115.0	95440	95440	70690	5/16	IC.33. 8	2 1/2			
18"	67.0	91350	119300	88360	1/4	IC.41. 9	2 9/16	6" × 6" × 3/8" 1' — 2½" Long	41 lbs.	
	72.0	98100	119300	88360	1/4	IC.41. 9	2 9/16			
	78.0	105980	119300	88360	5/16	IC.41. 8	2 1/2			
	86.0	96530	119300	88360	1/4	IC.41. 9	2 9/16			
	93.0	104180	119300	88360	5/16	IC.41. 8	2 1/2			
	100.0	112050	119300	88360	5/16	IC.41. 8	2 1/2			
21"	104.0	104630	119300	88360	5/16	IC.41. 8	2 1/2			
	112.0	112280	119300	88360	5/16	IC.41. 8	2 1/2			
	120.0	119300	119300	88360	5/16	IC.41. 8	2 1/2			

*Layer-out starts with this dimension at left end of beam. With beams ordered one inch short, as usual in standard shop practice, this leaves sufficient end distance or clearance at right end, in case of full allowable 3/8" underrun or 3/8" overrun in beam lengths.

CONNECTION ANGLES FOR CARNEGIE BEAMS

DIMENSIONS, WEIGHTS AND WORKING LOADS — **3/4" POWER DRIVEN RIVETS**

Beam		Connection Value				Connection Angles				
			Outstanding Single Shear							
Depth	Weight per foot	Web	Power Driven Rivets	Unfinished Bolts	Framing Distance C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	Connection Details.
24"	100.0	121500	143160	106030	5/16	IC.49. 8	2 1/2	6" × 6" × 3/8" 1' — 5½" Long	49 lbs.	
	110.0	133380	143160	106030	5/16	IC.49. 8	2 1/2			
	120.0	143160	143160	106030	5/16	IC.49. 8	2 1/2			
	130.0	143160	143160	106030	5/16	IC.49. 8	2 1/2			
	140.0	143160	143160	106030	3/8	IC.49. 7	2 7/16			
	150.0	143160	143160	106030	3/8	IC.49. 7	2 7/16			
	160.0	143160	143160	106030	3/8	IC.49. 7	2 7/16			
27"	145.0	167020	167020	123700	3/8	IC.58. 7	2 7/16	6" × 6" × 3/8" 1' — 8½" Long	58 lbs.	
	160.0	167020	167020	123700	3/8	IC.58. 7	2 7/16			
	175.0	167020	167020	123700	7/16	IC.58. 6	2 3/8			
	190.0	167020	167020	123700	7/16	IC.58. 6	2 3/8			
30"	180.0	190880	190880	141380	3/8	IC.66. 7	2 7/16	6" × 6" × 3/8" 1' — 11½" Long	66 lbs.	
	200.0	190880	190880	141380	7/16	IC.66. 6	2 3/8			
	220.0	190880	190880	141380	1/2	IC.66. 5	2 5/16			
	240.0	190880	190880	141380	1/2	IC.66. 5	2 5/16			



Following Beams can be framed opposite with tops flush when.—

A = 3" all 8", 9", 10", 12", 14", 16", 18", 21", and 24" (100 to 130#)
A = 3¼" all 9", 10", 12", 14", 16", 18", 21", 24", and 27" (145 and 160#)
A = 3½" all 9", 10", 12" (40 to 50#), 14", 16", 21", 24", 27", and 30" (180 and 200#)
A = 3¾" all 9", 10", 14", 16", 21", 24", 27", and 30".

Flange must be cut away as shown for field riveting on all beams framing opposite a larger beam, if flange interferes with outstanding rivets.

Minimum Web required to develop Single Shearing Value is .33"
Minimum Web required to develop Double Shearing Value is .53"

NOTES and DIAGRAMS

Part IV
Section 8

Miscellaneous Steel Sections

Dimensions

Technical Functions

Allowable Total Loads

by

A. I. S. C. Specification

Allowable End Reactions

Standard Connection Angles

for

Carnegie Mill Sections

Carnegie H Sections

J. and L. Junior Beams

Bethlehem Steel Joists

Phoenix Special I Beams

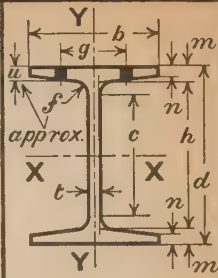
8″

CARNEGIE MILL SECTIONS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia   S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½″ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



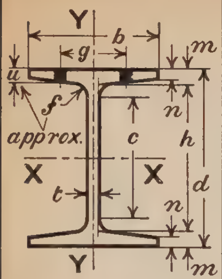
Depth = d″.	8.00	8.00
Wt. per foot.	17.5	21.0
Area Sq. In..	5.14	6.17
b″	4.981	5.110
t	.231	.360
h	7.108	7.108
m	.446	.446
n	.238	.238
f	.25	.25
c	6⅝	6⅝
g	2¼	2¼
u	⅜	⅜
AXES X-X I.	57.4	63.4
AXES X-X S.	14.35	15.85
AXES X-X r.	3.36	3.21
AXES Y-Y I.	6.0	6.6
AXES Y-Y S.	2.4	2.6
AXES Y-Y r.	1.08	1.03
Coef. Str.	172200	190200
Max. Mom. ″#	258300	285300
V	22180	34560
P. feet	3.88	2.76
R	19060	29700
W	20800	23860
Q. feet	4.14	3.99
w. lbs.	13	13
Rivet dia	¾	¾

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = Total Def. × Live Load / Tabular Load

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	17.5 lb. Laterally fixed	17.5 lb. Laterally free	21.0 lb. Laterally fixed	21.0 lb. Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	44.4	44.4	63.4	63.4	
4	42.9	42.9	47.6	47.6	.037
5	34.3	34.3	38.1	38.1	.058
6	28.6	28.6	31.7	31.7	.084
7	24.5	23.9	27.2	26.6	.114
8	21.5	20.1	23.8	22.5	.149
9	19.1	17.1	21.1	19.2	.189
10	17.2	14.8	19.0	16.6	.233
11	15.6	12.8	17.3	14.4	.281
12	14.3	11.2	15.9	12.6	.335
13	13.2	9.9	14.6	11.1	.394
14	12.3	8.7	13.6	9.8	.456
15	11.4		12.7	....	.524
16	10.7		11.9	....	.596
17	10.1		11.2	....	.674
18	9.6		10.6	....	.754
19	9.1		10.0	....	.840
20	8.6		9.5	....	.931



CARNEGIE MILL SECTIONS

9"

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for $3\frac{1}{2}''$ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.

CM

Depth = d".	9.00	9.00
Wt. per foot.	20.5	25.0
Area Sq. In..	6.02	7.34
b"	5.234	5.380
t.......	.234	.380
h	8.008	8.008
m......	.496	.496
n	.277	.277
f.......	.275	.275
c.......	7½	7½
g.......	2½	2½
u	13/32	13/32
AXES X-X I....	86.6	95.5
AXES X-X S ...	19.24	21.22
AXES X-X r....	3.79	3.61
AXES Y-Y I....	8.0	8.8
AXES Y-Y S ...	3.1	3.3
AXES Y-Y r....	1.15	1.09
Coef. Str	230930	254670
Max.Mom."#	346400	382000
V	25270	41040
P. feet ..	4.57	3.10
R......	19430	32770
W......	21060	23860
Q. feet..	5.48	5.34
w. lbs...	13	13
Rivet dia....	¾	¾

Live Load deflection must not exceed 1/360 of the Span.

Live Load Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Total Deflection in inches for Maximum Load; Laterally fixed beam.
3	50.5	50.5	82.1	82.1	
4	50.5	50.5	63.7	63.7	
5	46.1	46.1	50.9	50.9	.052
6	38.4	38.4	42.4	42.4	.074
7	32.9	32.4	36.4	36.1	.101
8	28.8	27.4	31.8	30.6	.132
9	25.6	23.4	28.3	26.2	.168
10	23.1	20.2	25.5	22.7	.207
11	20.9	17.6	23.1	19.8	.250
12	19.2	15.5	21.2	17.4	.298
13	17.7	13.7	19.6	15.3	.350
14	16.5	12.1	18.2	13.6	.406
15	15.4	10.7	17.0	12.1	.466
16	14.4	9.6	15.9	10.8	.530
17	13.6		15.0	....	.599
18	12.8		14.1	....	.670
19	12.1		13.4	....	.747
20	11.5		12.7	....	.828

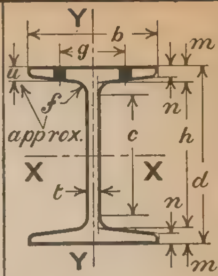
4" TO 8"

CARNEGIE H BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



Depth = d"	4"	5"	6"	6"	6"	6"	8"	8"	8"
Weight per foot	13.8	18.9	20.0	22.5	25.0	27.5	32.6	34.3	37.7
Area Sq In.	3.99	5.47	5.86	6.61	7.33	8.08	9.50	10.00	11.00
b"	4.000	5.000	5.938	6.063	5.938	6.063	7.938	8.000	8.125
t	.313	.313	.250	.375	.313	.438	.313	.375	.500
h	3.094	3.994	5.042	5.042	4.840	4.840	6.880	6.880	6.880
m	.453	.503	.479	.479	.580	.580	.560	.560	.560
n	.290	.330	.280	.280	.381	.381	.358	.358	.358
f	.313	.313	.313	.313	.313	.313	.313	.313	.313
c	2.522	3.413	4.458	4.458	4.256	4.256	6.287	6.287	6.287
g	2¼	2¾	3½	3½	3½	3½	4"	4"	4"
u	⅜	7/16	⅜	⅜	½	½	½	½	½
AXES X-X I	10.7	23.8	38.8	41.0	47.0	49.3	112.8	115.5	120.8
AXES X-X S	5.35	9.52	12.93	13.67	15.67	16.43	28.20	28.88	30.20
AXES X-X r	1.64	2.08	2.57	2.49	2.53	2.47	3.45	3.40	3.31
AXES Y-Y I	3.6	7.8	11.4	12.2	14.9	16.0	34.2	35.1	36.9
AXES Y-Y S	1.8	3.1	3.8	4.0	5.0	5.3	8.6	8.8	9.1
AXES Y-Y r	0.95	1.20	1.39	1.36	1.43	1.41	1.90	1.87	1.83
Coef Str.	64200	114240	155160	164040	188040	197160	338400	346560	362400
Max Mom."#	96300	173160	232740	246060	282060	295740	507600	519840	543600
V	15020	18780	18000	27000	22540	31540	30050	36000	48000
P. feet	2.14	3.04	4.31	3.04	4.17	3.13	5.63	4.81	3.78
R	21130	22300	18750	28130	23480	32850	25820	30940	41250
W	11930	11930	11250	11930	11930	11930	23860	23860	23860
Q. feet	2.69	4.79	6.90	6.88	7.88	8.26	7.09	7.26	7.59
w. lbs	6	6	6	6	6	6	13	13	13
Rivet dia.	⅝	⅝	¾	¾	¾	¾	¾	¾	¾

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free	Laterally fixed	Laterally free
3	21.2	21.2	37.6	37.6	36.0	36.0	54.0	54.0	45.1	45.1	63.1	63.1	60.1	60.1	72.0	72.0	96.0	96.0
4	15.9	15.9	28.5	28.5	36.0	36 0	41.0	41.0	45.1	45.1	49.3	49.3	60.1	60.1	72.0	72.0	90.6	90.6
5	12.7	12.7	22.8	22.8	31.0	31.0	32.8	32.8	37.6	37.6	39.4	39.4	60.1	60.1	69.4	69.4	72.5	72.5
6	10.6	10.1	19.0	19.0	25.9	25.9	27.4	27.4	31.4	31.4	32.9	32.9	56.4	56.4	57.8	57.8	60.4	60.4
7	9.1	8.3	16.3	15.9	22.2	22.2	23.4	23.4	26.9	26.9	28.2	28.2	48.3	48.3	49.5	49.5	51.8	51.8
8	8.0	....	14.3	13.4	19.4	19.0	20.5	20.3	23.5	23.1	24.6	24.4	42.3	42.3	43.4	43.4	45.3	45.3
9	7.1	....	12.7	....	17.2	16.4	18.2	17.5	20.9	19.9	21.9	21.0	37.6	37.6	38.5	38.5	40.3	40.3
10	6.4	....	11.4	....	15.5	14.3	16.4	15.3	18.8	17.3	19.7	18.3	33.8	33.8	34.7	34.7	36.2	36.2
11	5.8	....	10.4	....	14.1	....	14.9	....	17.1	....	17.9	....	30.8	30.0	31.5	30.8	32.9	32.3
12	5.4	....	9.5	....	12.9	....	13.7	....	15.7	....	16.4	....	28.2	26.9	28.9	27.6	30.2	29.0
13	....	....	8.9	....	11.9	....	12.6	....	14.5	....	15.2	....	26.0	24.2	26.7	24.9	27.9	26.1
14	....	....	8.2	....	11.1	....	11.7	....	13.4	....	14.1	....	24.2	21.9	24.8	22.6	25.9	23.7
15	....	....	....	....	10.3	....	10.9	....	12.5	....	13.1	....	22.6	....	23.1	....	24.2	....
16	....	....	....	....	....	....	....	....	....	....	....	....	21.2	....	21.7	....	22.7	....
17	....	....	....	....	....	....	....	....	....	....	....	....	19.9	....	20.4	....	21.3	....

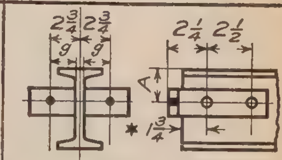
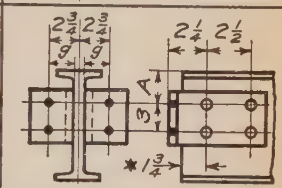
Total Deflection in inches for Maximum Load; Laterally fixed beam. Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = $\frac{\text{Total Def} \times \text{Live Load}}{\text{Tabular Load}}$

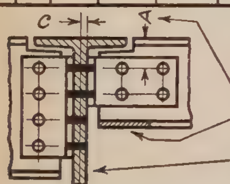
Span feet	4"	5"	6"	6"	6"	6"	8"	8"	8"
3	.042	....	....	....	....	....	....	....	....
4	.074	.059	....	.050	....	.050	....	....	.037
5	.116	.093	.078	.078	.078	.078	....	.058	.058
6	.168	.134	.112	.112	.112	.112	.084	.084	.084
7	.228	.182	.152	.152	.152	.152	.114	.114	.114
8	.298	.238	.198	.198	.198	.198	.149	.149	.149
9	.378	.302	.252	.252	.252	.252	.189	.189	.189
10	.465	.372	.310	.310	.310	.310	.233	.233	.233
11	.562	.450	.375	.375	.375	.375	.281	.281	.281
12	.670	.537	.447	.447	.447	.447	.335	.335	.335
13	....	.630	.525	.525	.525	.525	.394	.394	.394
14	....	.730	.608	.608	.608	.608	.456	.456	.456
15	....	....	.698	.698	.698	.698	.524	.524	.524
16	....	....	....	....	....	....	.596	.596	.596
17	....	....	....	....	....	....	.674	.674	.674

LOADS BY A. I. S C. SPECIFICATION

CONNECTION ANGLES FOR CARNEGIE MILL SECTIONS AND H BEAMS

DIMENSIONS, WEIGHTS, AND WORKING LOADS — **¾" POWER DRIVEN RIVETS**

Beam Type	Beam Depth	Beam Weight per foot	Connection Value Web	Connection Value Outstanding Single Shear Power Driven Rivets	Connection Value Outstanding Single Shear Unfinished Bolts	Framing Distance C	Connection Angles A.I.S.C. Mark	Connection Angles Gage g	Connection Angles Size and Length	Connection Angles Weight inc Web Rivets	Connection Details
H Beams	4	13.8	14090	11930	8840	¼	IC. 6. 9	2 9/16	6" × 4" × ⅜" 0' — 2½" Long	6 lbs.	
H Beams	5	18.9	14090	11930	8840	¼	IC. 6. 9	2 9/16			
H Beams	6	20.0	11250	11930	8840	3/16	IC. 6.10	2 ⅝			
		22.5	16880	11930	8840	¼	IC. 6. 9	2 9/16			
		25.0	14090	11930	8840	¼	IC. 6. 9	2 9/16			
		27.5	19710	11930	8840	5/16	IC. 6. 8	2 ½			
H Beams	8	32.6	28170	23860	17670	¼	IC.13. 9	2 9/16	6" × 4" × ⅜" 0' — 5½" Long	13 lbs.	
		34.3	33750	23860	17670	¼	IC.13. 9	2 9/16			
		37.7	45000	23860	17670	5/16	IC.13. 8	2 ½			
Mill Sections	8	17.5	20800	23860	17670	3/16	IC.13.10	2 ⅝			
		21.0	32400	23860	17670	¼	IC.13. 9	2 9/16			
Mill Sections	9	20.5	21100	23860	17670	3/16	IC.13.10	2 ⅝			
		25.0	34200	23860	17670	¼	IC.13. 9	2 9/16			



*Layer-out starts with this dimension at left end of beam. With beams ordered one inch short, as usual in standard shop practice, this leaves sufficient end distance or clearance at right end, in case of full allowable ⅜" underrun or ⅜" overrun in beam lengths.

When A = 3" all beams except 4" H, can be framed opposite with tops flush.

Flange must be cut away as shown for field riveting on all beams framing opposite a larger beam, if flange interferes with outstanding rivets.

Minimum Web required to develop Single Shearing Value is .33".
Minimum Web required to develop Double Shearing Value is .53".

ALLOWABLE END REACTIONS FOR CARNEGIE MILL SECTIONS AND H BEAMS

DETERMINED BY

BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Type	Depth	Weight per foot	Web t	Unit Stress in Buckling	Reaction R for 3½" Bearing	Min. Span for 3½" Bearing	Reaction R for 5½" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V.	Length of Bearing to develop V.
H Beams	4	13.8	.313	15000	21130	1.52	30520	4700	15020	2.20
H Beams	5	18.9	.313	15000	22300	2.56	31690	4700	18780	2.75
H Beams	6	20.0	.250	15000	18750	4.14	26250	3750	18000	3 30
		22.5	.375	15000	28130	2.92	39380	5630	27000	3 30
		25.0	.313	15000	23480	4.00	32870	4700	22540	3.30
		27.5	.438	15000	32850	3.00	45990	6570	31540	3 30
H Beams	8	32.6	.313	15000	25820	6.55	35210	4700	30050	4.40
		34.3	.375	15000	30940	5.60	42190	5630	36000	4.40
		37.7	.500	15000	41250	4.39	56250	7500	48000	4.40
Mill Sects.	8	17.5	.231	15000	19060	4.52	25990	3470	22180	4.40
		21.0	.360	15000	29700	3.99	40500	5400	34560	4.40
Mill Sects.	9	20.5	.234	14400	19430	5.94	26180	3380	25270	5.23
		25.0	.380	15000	32770	5.34	44170	5700	41040	4.95

The beam web is treated as a column with fixed ends, having an effective length l of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.

When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

6" TO 12"

J

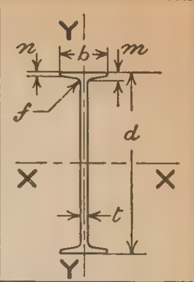
J AND L JUNIOR BEAMS

ROLLED FROM COPPER BEARING STEEL

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 2½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



		6"	7"	8"	9"	10"	11"	12"
Depth = d"		6.028	7.028	8.028	9.018	10.026	11.024	12.028
Weight per foot		4.41	5.48	6.54	7.48	8.96	10.23	11.74
Area Sq. In.		1.30	1.61	1.92	2.20	2.64	3.01	3.45
b"		1.84	2.08	2.28	2.38	2.69	2.84	3.06
t"		.114	.126	.135	.145	.155	.165	.175
m		.200	.212	.224	.231	.247	.258	.272
n		.142	.148	.154	.155	.165	.170	.178
f		.150	.165	.180	.195	.210	.225	.240
AXES X-X	I	7.30	12.13	18.67	26.20	39.01	53.08	72.21
	S	2.42	3.45	4.65	5.81	7.78	9.63	12.01
	r	2.372	2.744	3.116	3.450	3.847	4.200	4.573
AXES Y-Y	I	.1654	.2482	.3434	.3939	.6078	.7459	.9776
	S	.1794	.2389	.3011	.3317	.4523	.5246	.6385
	r	.3569	.3925	.4226	.4230	.4802	.4979	.5320
Coef. Str.		29074	41425	55817	69727	93369	115555	144088
Max. Mom."#		43610	62137	83726	104591	140054	173332	216131
V		8210	10580	12960	15660	18330	20930	23700
P. feet		1.77	1.96	2.15	2.23	2.55	2.76	3.04
R		5620	6370	6900	7550	8240	8960	9710
W		5130	5670	6075	6525	6975	7425	7875
Q. feet		2.83	3.65	4.59	5.34	6.69	7.78	9.15
w. lbs		4	5	5	5	5	5	5

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	6" Laterally fixed	6" Laterally free	7" Laterally fixed	7" Laterally free	8" Laterally fixed	8" Laterally free	9" Laterally fixed	9" Laterally free	10" Laterally fixed	10" Laterally free	11" Laterally fixed	11" Laterally free	12" Laterally fixed	12" Laterally free
6	4.85	3.05	6.90	4.80	9.30	6.90	11.62	8.86	15.56	12.73	19.26	16.20	24.02	20.90
7	4.15	....	5.92	....	7.97	5.28	9.96	6.82	13.34	9.96	16.51	12.76	20.58	16.61
8	3.63	....	5.18	....	6.98	....	8.72	5.34	11.67	7.92	14.44	10.21	18.01	13.41
9	3.23	....	4.60	....	6.20	....	7.75	....	10.37	....	12.84	8.28	16.01	10.96
10	2.91	....	4.14	....	5.58	....	6.97	....	9.34	....	11.56	....	14.41	....
11	2.64	....	3.77	....	5.07	....	6.34	....	8.49	....	10.51	....	13.10	....
12	2.42	....	3.45	....	4.65	....	5.81	....	7.78	....	9.63	....	12.01	....
13	2.24	....	3.19	....	4.29	....	5.36	....	7.18	....	8.89	....	11.08	....
14	2.08	....	2.96	....	3.99	....	4.98	....	6.67	....	8.25	....	10.29	....
15	1.94	....	2.76	....	3.72	....	4.65	....	6.23	....	7.70	....	9.61	....
16	1.82	....	2.59	....	3.49	....	4.36	....	5.84	....	7.22	....	9.01	....
17	1.71	....	2.44	....	3.28	....	4.10	....	5.49	....	6.80	....	8.48	....
18	1.62	....	2.30	....	3.10	....	3.87	....	5.19	....	6.42	....	8.01	....
19	1.53	....	2.18	....	2.94	....	3.67	....	4.91	....	6.08	....	7.58	....
20	1.45	....	2.07	....	2.79	....	3.49	....	4.67	....	5.78	....	7.20	....
21	1.38	....	1.97	....	2.66	....	3.32	....	4.45	....	5.50	....	6.86	....
22	1.32	....	1.88	....	2.54	....	3.17	....	4.24	....	5.25	....	6.55	....
23	1.26	....	1.80	....	2.43	....	3.03	....	4.06	....	5.02	....	6.27	....
24	1.21	....	1.73	....	2.33	....	2.91	....	3.89	....	4.82	....	6.00	....
25	1.16	....	1.66	....	2.23	....	2.79	....	3.74	....	4.62	....	5.76	....
26	1.12	....	1.59	....	2.15	....	2.68	....	3.59	....	4.44	....	5.54	....

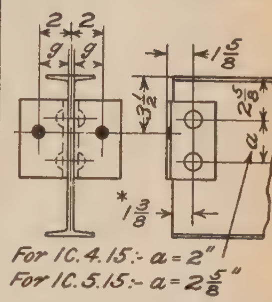
Total Deflection in inches for Maximum Load; Laterally fixed beam. Live Load deflection must not exceed 1/360 of the Span. Live Load Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$

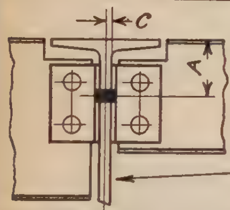
Span feet	6"	7"	8"	9"	10"	11"	12"
9	.252	.216	.189	.168	.151	.137	.126
10	.310	.266	.233	.207	.186	.169	.155
11	.375	.321	.281	.250	.225	.205	.188
12	.447	.383	.335	.298	.268	.244	.223
13	.525	.450	.394	.350	.315	.286	.263
14	.608	.521	.456	.406	.365	.332	.304
15	.698	.599	.524	.466	.419	.381	.341
16	.795	.681	.596	.530	.477	.434	.398
17	.898	.770	.674	.599	.539	.490	.449
18	1.01	.861	.754	.670	.603	.548	.503
19	1.12	.960	.840	.747	.672	.611	.560
20	1.24	1.06	.931	.828	.745	.677	.621
21	1.37	1.17	1.03	.912	.821	.746	.684
22	1.51	1.29	1.13	1.00	.901	.819	.751
24	1.79	1.53	1.34	1.19	1.07	.975	.894
26	2.10	1.80	1.57	1.40	1.26	1.14	1.05

CONNECTION ANGLES FOR J AND L JUNIOR BEAMS

DIMENSIONS, WEIGHTS, AND WORKING LOADS — **3/4" POWER DRIVEN RIVETS**

Beam		Connection Value			Framing Distance	Connection Angles				Connection Details
			Outstanding Single Shear							
Depth	Weight per foot	Web	Power Driven Rivets	Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	
6"	4.41	5130	9000	6000	1/8	IC. 4.15	1 15/16	3 x 3 x 1/4 4 1/4" Long	4 lbs.	
7"	5.48	5670	9000	6000	1/8	IC. 5.15	1 15/16	3 x 3 x 1/4 4 7/8" Long	5 lbs.	
8"	6.54	6075	9000	6000	1/8	IC. 5.15	1 15/16			
9"	7.48	6525	9000	6000	1/8	IC. 5.15	1 15/16			
10"	8.96	6975	9000	6000	1/8	IC. 5.15	1 15/16			
11"	10.23	7425	9000	6000	1/8	IC. 5.15	1 15/16			
12"	11.74	7875	9000	6000	1/8	IC. 5.15	1 15/16			





*Layer-out starts with this dimension at left end of beam. With beams ordered one half inch short, as recommended for J & L Junior beams, this leaves sufficient end distance at right end, in case of full allowable 3/8" underrun in beam lengths.

When A = 3½" all Junior beams can be framed opposite with tops flush.

Minimum Web required to develop Single Shearing Value is .33"
Minimum Web required to develop Double Shearing Value is .53"

ALLOWABLE END REACTIONS FOR J AND L JUNIOR BEAMS

DETERMINED BY

BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight per Foot	Web t	Unit Stress in Buckling	Reaction R for 2½" Bearing	Min. Span for 2½" Bearing	Reaction R for 3½" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V.	Length of Bearing to develop V.
6"	4.41	.114	12310	5620	2.59	7020	1400	8210	4.35
7"	5.48	.126	11890	6370	3.25	7860	1500	10580	5.32
8"	6.54	.135	11360	6900	4.05	8430	1530	12960	6.45
9"	7.48	.145	10960	7550	4.62	9140	1590	15660	7.60
10"	8.96	.155	10630	8240	5.67	9880	1650	18330	8.63
11"	10.23	.165	10340	8960	6.45	10660	1710	20930	9.52
12"	11.74	.175	10090	9710	7.42	11480	1770	23700	10.42

The beam web is treated as a column with fixed ends, having an effective length L of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.
When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

6″ TO 12″

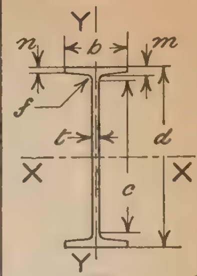
BJ

BETHLEHEM STEEL JOISTS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 2½″ bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



			6″	8″	10″	12″
Depth = d″			6″	8″	10″	12″
Wt. per foot			11.0	14.5	16.5	18.5
Area. Sq. In			3.25	4.28	4.86	5.44
b″			3.33	3.875	4.000	4.125
t			.230	.240	.240	.240
m			.359	.391	.397	.402
n			.230	.240	.240	.240
f			.25	.30	.30	.30
c			4.82	6.67	8.65	10.64
AXES	X-X	I	19.3	44.9	77.4	121.5
		S	6.43	11.23	15.48	20.25
		r	2.44	3.24	3.99	4.73
	Y-Y	I	1.64	2.73	3.02	3.33
		S	.98	1.41	1.51	1.61
		r	.71	.80	.79	.78
Coef. Str.			77200	134700	185760	243000
Max. Mom.″#			115800	202050	278640	364500
V			16560	23040	28800	34560
P. feet			2.33	2.92	3.23	3.52
R			13800	16200	16750	16770
W			10360	10800	10800	10800
Q. feet			3.72	6.24	8.6	11.25
w. lbs			6	9	9	9

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least.
For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	6″ Laterally fixed	6″ Laterally free	8″ Laterally fixed	8″ Laterally free	10″ Laterally fixed	10″ Laterally free	12″ Laterally fixed	12″ Laterally free
6	12.86	11.58	22.45	20.92	30.96	29.60	40.50	39.05
7	11.02	9.29	19.24	17.31	26.54	24.16	34.71	31.94
8	9.65	7.58	16.84	14.31	23.22	20.03	30.38	26.56
9	8.57	6.24	14.97	11.98	20.64	16.81	27.00	22.34
10	7.72	5.20	13.47	10.12	18.58	14.24	24.30	18.97
11	7.01	4.36	12.25	8.61	16.89	12.15	22.09	16.23
12	6.43	....	11.22	7.37	15.48	10.44	20.25	13.98
13	5.94	....	10.36	....	14.29	9.02	18.69	12.11
14	5.51	....	9.62	....	13.27	....	17.36	....
15	5.14	....	8.98	....	12.38	....	16.20	....
16	4.83	....	8.42	....	11.61	....	15.19	....
17	4.54	....	7.92	....	10.93	....	14.29	....
18	4.29	....	7.48	....	10.32	....	13.50	....
19	4.06	....	7.09	....	9.78	....	12.79	....
20	3.86	....	6.74	....	9.29	....	12.15	....
22	3.51	....	6.12	....	8.44	....	11.05	....
24	3.22	....	5.61	....	7.74	....	10.13	....
26	2.97	....	5.18	....	7.14	....	9.35	....

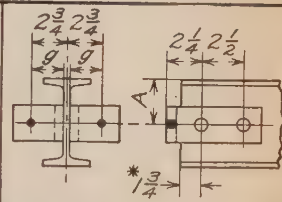
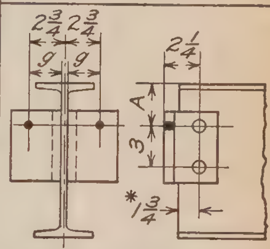
Total Deflection in inches for Maximum Load; Laterally fixed beam.
Live Load deflection must not exceed 1/360 of the Span.
Live Load Def. = $\frac{\text{Total Def.} \times \text{Live Load}}{\text{Tabular Load}}$

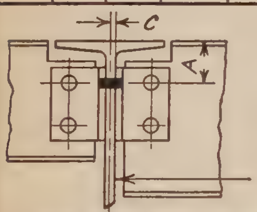
Span feet	6″	8″	10″	12″
6	.112	.084	.067	.056
7	.152	.114	.091	.076
8	.198	.149	.119	.099
9	.252	.189	.151	.126
10	.310	.233	.186	.155
11	.375	.281	.225	.188
12	.447	.335	.268	.223
13	.525	.394	.315	.263
14	.608	.456	.365	.304
15	.698	.524	.419	.341
16	.795	.596	.477	.398
17	.898	.674	.539	.449
18	1.01	.754	.603	.503
19	1.12	.840	.672	.560
20	1.24	.931	.745	.621
22	1.51	1.13	.901	.751
24	1.79	1.34	1.07	.894
26	2.10	1.57	1.26	1.05

LOADS BY A. I. S. C. SPECIFICATION

CONNECTION ANGLES FOR BETHLEHEM STEEL JOISTS

DIMENSIONS, WEIGHTS, AND WORKING LOADS — **3/4" POWER DRIVEN RIVETS**

Beam		Connection Value			Framing Distance	Connection Angles				Connection Details
Depth	Weight per foot	Web	Outstanding Single Shear: Power Driven Rivets	Outstanding Single Shear: Unfinished Bolts	C	A.I.S.C. Mark	Gage g	Size and Length	Weight inc. Web Rivets	
6"	11.0	10360	11930	8840	3/16	IC. 6.10	2 5/8	6" × 4" × 3/8" 0'—2 1/2" Long	6 lbs.	
8"	14.5	10800	11930	8840	3/16	IC. 9.10	2 5/8	4" × 3 1/2" × 3/8" 0'—5 1/2" Long	9 lbs.	
10"	16.5	10800	11930	8840	3/16	IC. 9.10	2 5/8			
12"	18.5	10800	11930	8840	3/16	IC. 9.10	2 5/8			



*Layer-out starts with this dimension at left end of beam. With beams ordered one half inch short, as recommended for Bethlehem Steel Joists, this leaves sufficient end distance at right end, in case of full allowable 3/8" underrun in beam lengths.

When A = 3" all Bethlehem Steel Joists can be framed opposite with tops flush.

Minimum Web required to develop Single Shearing Value is .33"
Minimum Web required to develop Double Shearing Value is .53"

ALLOWABLE END REACTIONS FOR BETHLEHEM STEEL JOISTS

DETERMINED BY

BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight per Foot	Web t	Unit Stress in Buckling	Reaction R for 2 1/2" Bearing	Min. Span for 2 1/2" Bearing	Reaction R for 3 1/2" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V.	Length of Bearing to develop V.
6"	11.0	.230	15000	13800	2.80	17250	3450	16560	3.30
8"	14.5	.240	15000	16200	4.16	19800	3600	23040	4.40
10"	16.5	.240	13960	16750	5.55	20100	3350	28800	6.10
12"	18.5	.240	12706	16770	7.25	19820	3050	34560	8.33

The beam web is treated as a column with fixed ends, having an effective length L of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.
When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

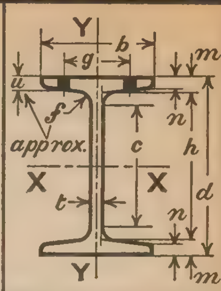
12" AND 15" P

SPECIAL PHOENIX I BEAMS

DIMENSIONS—FUNCTIONS—ALLOWABLE TOTAL LOADS

I is Moment of Inertia S is Section Modulus
r is Radius of Gyration
V is Maximum Web Shear in Pounds.
P is Minimum Span in feet, uniformly loaded to cause V.
R is Allowable End Reaction for 3½" bearing. For details see page of Allowable End Reactions.
W is Maximum Load on one Standard Connection.
Q is Minimum Span in feet, uniformly loaded to cause W.
w is Weight of one Standard Connection including Angles and Web Rivets

Rivet given is Maximum Diameter in flange.
Allowable concentrated center loads are 50% and their deflections 80% of those shown.



DIMENSIONS AND FUNCTIONS

Depth = d"		12"	15"
Wt. per foot.		27.5	36.0
Area........		8.09	10.59
b".....		5.00	5.50
t.......		.255	.289
h.......		10.580	13.390
m.......		.710	.805
n.......		.315	.371
f.......		.40	.45
c.......		9¾	12⅝
g.......		3	3½
u.......		½	9/16
AXES X-X	I....	199.6	405.1
	S....	33.27	54.01
	r....	4.98	6.17
AXES Y-Y	I....	8.70	13.50
	S....	3.48	4.91
	r....	1.04	1.13
Coef. Str....		399200	648160
Max.Mom."#		598800	972240
V.......		36700	52000
P. feet..		5.44	6.23
R.......		21800	26000
W......		22950	26010
Q. feet..		8.70	12 46
w lbs...		13	19
Rivet dia....		¾	¾

ALLOWABLE LOADS AND DEFLECTIONS

Allowable Uniform Load in Kips, as fixed by shear or flexure, whichever is least. For laterally fixed beam loads not tabulated, divide the Coefficient of Strength by the Span in feet.

Span feet	12" Laterally fixed	12" Laterally free	12" Total Deflect.	15" Laterally fixed	15" Laterally free	15" Total Deflect.
4	73.4	73.4	.025	104	104	.020
5	73.4	73.4	.039	104	104	.031
6	66.5	66.5	.056	104	104	.045
7	57.0	55.5	.076	92.6	92.1	.061
8	49.9	46.8	.099	81.0	78.1	.079
9	44.4	40.0	.126	72.0	67.1	.101
10	39.9	34.4	.155	64.8	58.2	.124
11	36.3	29.9	.188	58.9	50.8	.150
12	33.3	26.2	.223	54.0	44.7	.179
13	30.7	22.9	.263	49.9	39.5	.210
14	28.5	20.2	.304	46.3	35.1	.243
15	26.6	17.9	.341	43.2	31.3	.279
16	25.0	16.0	.398	40.5	28.0	.318
17	23.5	....	.449	38.1	25.1	.359
18	22.2	....	.503	36.0	22.6	.402
19	21.0	....	.560	34.1	....	.448
20	20.0	....	.621	32.4	....	.497
21	19.0	....	.684	30.9	....	.547
22	18.1	....	.751	29.5	....	.601
23	17.4	....	.822	28.2	....	.651

Deflection: Live Load deflection must not exceed 1-360 of the Span. $\text{Live Load Def.} = \text{Tot.Def.} \times \frac{\text{Live Load}}{\text{Tabular Load}}$

Total Deflection in inches for Max. Load; Laterally fixed beam.

CONNECTION ANGLES FOR SPECIAL PHOENIX I BEAMS

DIMENSIONS, WEIGHTS, AND WORKING LOADS — **¾" POWER DRIVEN RIVETS**

Beam Depth	Beam Weight per foot	Connection Value Web	Connection Value Outstanding Single Shear Power Driven Rivets	Connection Value Outstanding Single Shear Unfinished Bolts	Framing Distance C	Connection Angles A.I.S.C. Mark	Connection Angles Gage g	Connection Angles Size and Length	Connection Angles Weight inc. Web Rivets	Connection Details
12"	27.5	22950	23860	17670	3/16	IC.13.10	2⅝		13	For complete details see drawing of Connection Angles of same weight as used for American Std. Beams.
15"	36.0	26010	47720	35340	3/16	IC.19.10	2⅝		19	

ALLOWABLE END REACTIONS FOR SPECIAL PHOENIX I BEAMS DETERMINED BY BUCKLING OF UNSTIFFENED WEBS OVER VARIOUS LENGTHS OF BEARING

Depth in Inches	Weight per Foot	Web t	Unit Stress in Buckling	Reaction R for 3½" Bearing	Min. Span for 3½" Bearing	Reaction R for 5½" Bearing	Increase in R for 1" Additional Bearing	Max. Web Shear V.	Length of Bearing to develop V.
12	27.5	.255	13150	21800	9.16	28500	3350	36700	7.96
15	36.0	.289	12420	26000	12.46	33200	3590	52000	10.74

The beam web is treated as a column with fixed ends, having an effective length L of one-half the beam depth. The unit stress is determined by the A. I. S. C. column formula. The length of web resisting buckling is assumed as the actual bearing on the bracket or wall plate plus one-fourth the beam depth. This agrees with the results of numerous tests.
When the reaction from the load exceeds the allowable reaction R, the beam web must be stiffened or additional length of bearing provided; but in no case shall the reaction exceed the allowable shearing value V.

Part IV

Section 9

Beam Summary

giving

Size and Weight

of

Beams

to be used for

Spans

from 4—50 feet

and for

Loads

from 1—650 Kips.

Continuous Load, Uniformly Distributed

SUMMARY OF BEAMS FOR VARIOUS UNIFORM LOADS AND SPANS

Size and Kind	Weight per Foot	Section Modulus	SPAN IN FEET—BEAMS LATERALLY FIXED																
			4	5	6	7	8	9	10	11	12	13	14	15	16	18	20	22	24
3″ I	5.7	1.67	5.0	4.0	3.3	2.9	2.5	2.2	2.0	1.8	1.7	1.5	1.4	1.3					
3″ I	6.5	1.80	5.4	4.3	3.6	3.1	2.7	2.4	2.2	2.0	1.8	1.7	1.5	1.4					
3″ I	7.5	1.93	5.8	4.6	3.9	3.3	2.9	2.6	2.3	2.1	1.9	1.8	1.7	1.5					
6″ J	4.41	2.42	7.3	5.8	4.9	4.2	3.6	3.2	2.9	2.6	2.4	2.2	2.1	1.9					
4″ I	7.7	3.00	9.0	7.2	6.0	5.1	4.5	4.0	3.6	3.3	3.0	2.8	2.6	2.4					
4″ I	8.5	3.15	10	8	6	5	5	4	4	3	3	3	3	3					
7″ J	5.48	3.45	10	8	7	6	5	5	4	4	3	3	3	3					
4″ I	9.5	3.35	10	8	7	6	5	5	4	4	3	3	3	3					
4″ I	10.5	3.55	11	9	7	6	5	5	4	4	4	3	3	3					
8″ J	6.54	4.65	14	11	9	8	7	6	6	5	5	4	4	4	3	3	3		
5″ I	10.0	4.84	15	12	10	8	7	7	6	5	5	5	4	4	4	3	3		
5″ I	12.25	5.40	16	13	11	9	8	7	7	6	5	5	5	4	4	4	3		
9″ J	7.48	5.81	17	14	12	10	9	8	7	6	6	5	5	5	4	4	3		
5″ I	14.75	6.00	18	14	12	10	9	8	7	7	6	6	5	5	5	4	4		
6″ BJ	11.0	6.43	19	15	13	11	10	9	8	7	6	6	6	5	5	4	4	4	3
10″ J	8.96	7.78	23	19	16	13	12	10	9	8	8	7	7	6	6	5	5	4	4
6″ I	12.5	7.27	22	17	15	13	11	10	9	8	7	7	6	6	6	5	4	4	4
6″ I	14.75	7.93	24	19	16	14	12	11	10	9	8	7	7	6	6	5	5	4	4
6″ I	17.25	8.67	26	21	17	15	13	12	10	10	9	8	7	7	7	6	5	5	4
11″ J	10.23	9.63	29	23	19	17	14	13	12	11	10	9	8	8	7	6	6	5	5
7″ I	15.3	10.34	31	25	21	18	16	14	12	11	10	10	9	8	8	7	6	6	5
7″ I	17.5	11.11	33	27	22	19	17	15	13	12	11	10	10	9	8	7	7	6	6
8″ BJ	14.5	11.23	34	27	22	19	17	15	13	12	11	10	10	9	8	7	7	6	6
12″ J	11.74	12.01	36	29	24	21	18	16	14	13	12	11	10	10	9	8	7	7	6
7″ I	20.0	11.97	36	29	24	21	18	16	14	13	12	11	10	10	9	8	7	7	6
8″ I	18.4	14.22	43	34	29	24	21	19	17	16	14	13	12	11	11	9	9	8	7
8″ Cm	17.5	14.35	43	34	29	25	22	19	17	16	14	13	12	11	11	10	9		
8″ B	17.5	14.43	43	35	29	25	22	19	17	16	14	13	12	12	11				
8″ I	20.5	15.05	45	36	30	26	23	20	18	16	15	14	13	12	11	10	9	8	8
10″ BJ	16.5	15.48	46	37	31	27	23	21	19	17	15	14	13	12	12	10	9	8	8
8″ B	19.0	15.81	47	38	32	27	24	21	19	17	16	15	14	13	12				
8″ Cm	21.0	15.85	48	38	32	27	24	21	19	17	16	15	14	13	12	11	10		
8″ I	23.0	16.05	48	39	32	28	24	21	19	18	16	15	14	13	12	11	10	9	8
8″ I	25.5	17.02	51	41	34	29	26	23	20	19	17	16	15	14	13	11	10	9	9
9″ I	21.8	18.87	57	45	38	32	28	25	23	21	19	17	16	15	14	13	11	10	9
9″ B	20.5	19.22	54	46	39	33	29	26	23	21	19	18	17	15	14	13			
9″ Cm	20.5	19.24	51	46	39	33	29	26	23	21	19	18	17	15	14	13	12		
12″ BJ	18.5	20.25	61	49	41	35	30	27	24	22	20	19	17	16	15	14	12	11	10
9″ I	25.0	20.31	61	49	41	35	31	27	24	22	20	19	17	16	15	14	12	11	10
9″ B	22.0	20.73	57	50	42	36	31	28	25	23	21	19	18	17	16	14			
8″ C	24.0	21.08	46	46	42	36	32	28	25	23	21	19	18	17	16	14	13	12	11
9″ Cm	25.0	21.22	64	51	42	36	32	28	26	23	21	20	18	17	16	14	13		
10″ C	21.0	21.73	55	52	44	37	33	29	26	24	22	20	19	17	16	15	13	12	11
10″ B	21.0	21.84	57	52	44	38	33	29	26	24	22	20	19	18	16	15	13		
9″ I	30.0	22.53	68	54	45	39	34	30	27	25	23	21	19	18	17	15	14	12	11
8″ C	27.0	23.68	52	52	47	41	36	32	28	26	24	22	20	19	18	16	14	13	12
10″ I	25.4	24.42	73	59	49	42	37	33	29	27	24	23	21	20	18	16	15	13	12
10″ C	23.0	24.44	55	55	49	42	37	33	29	27	24	23	21	20	18	16	15	13	12
10″ B	23.5	24.64	60	59	49	42	37	33	30	27	25	23	21	20	19	16	15		
9″ I	35.0	24.73	74	59	50	42	37	33	30	27	25	23	21	20	19	17	15	14	12
8″ G	29.5	25.56	54	54	51	44	38	34	31	28	26	24	22	20	19	17	15		
8″ C	30.0	26.31	59	59	53	45	40	35	32	29	26	24	23	21	20	18	16	14	13
10″ I	30.0	26.70	80	64	53	46	40	36	32	29	27	25	23	21	20	18	16	15	13
10″ B	26.0	27.33	65	65	55	47	41	36	33	30	27	25	23	22	21	18	16		
8″ C	31.0	27.52	56	56	55	47	41	37	33	30	28	25	24	22	21	18	17	15	14
10″ C	26.0	27.63	63	63	55	47	41	37	33	30	28	26	24	22	21	18	17	15	14
9″ C	29.0	28.00	60	60	56	48	42	37	34	31	28	26	24	22	21	19	17	15	14
8″ G	33.0	29.03	56	56	56	50	44	39	35	32	29	27	25	23	22	19	17		
10″ I	35.0	29.16	88	70	58	50	44	39	35	32	29	27	25	23	22	19	18	16	15
10″ B	28.5	30.25	70	70	61	52	45	40	36	33	30	28	26	24	23	20	18		
12″ C	25.0	30.69	69	69	61	53	46	41	37	34	31	28	26	25	23	21	18	17	15
9″ C	32.0	30.89	67	67	62	53	46	41	37	34	31	29	27	25	23	21	19	17	15
12″ B	25.0	31.16	68	68	62	53	47	42	37	34	31	29	27	25	23	21	19	17	16
10″ I	40.0	31.60	95	76	63	54	47	42	38	35	32	29	27	25	24	21	19	17	16
10″ C	30.0	31.91	73	73	64	55	48	43	38	35	32	30	27	26	24	21	19	17	16
8″ C	36.0	32.03	66	66	64	55	48	43	38	35	32	30	28	26	24	21	19	18	16
8″ G	36.5	32.66	60	60	60	56	49	44	39	36	33	30	28	26	24	22	20		
10″ C	31.0	32.68	77	77	65	56	49	44	39	36	33	30	28	26	25	22	20	18	16
12″ P.	27.5	33.27	73	73	67	57	50	44	40	36	33	31	29	27	25	22	20	18	
9″ C	35.0	33.81	74	74	68	58	51	45	41	37	34	31	29	27	25	23	20	18	17
10″ C	36.0	35.12	105	84	70	60	53	47	42	38	35	32	30	28	26	23	21	19	18
12″ C	28.0	35.57	69	69	69	61	53	47	43	39	36	33	31	28	27	24	21	19	18
12″ B	28.0	35.60	71	71	71	61	53	47	43	39	36	33	31	28	27	24	21	19	18
9″ G	36.0	35.91	62	62	62	62	54	48	43	39	36	33	31	29	27	24	22		

SUMMARY OF BEAMS FOR VARIOUS UNIFORM LOADS AND SPANS

Size and Kind	Weight per Foot	Section Modulus	SPAN IN FEET — BEAMS LATERALLY FIXED																		
			4	6	8	10	11	12	13	14	15	16	18	20	22	24	26	28	30
12" I	31.8	35.97	101	72	54	43	39	36	33	31	29	27	24	22	20	18			
8" C	42.0	37.37	78	75	56	45	41	37	35	32	30	28	25	22	20	19			
12" I	35.0	37.83	114	76	57	45	41	38	35	32	30	28	25	23	21	19			
9" C	38.0	37.87	68	68	57	45	41	38	35	33	30	28	25	23	21	19			
10" C	42.0	38.08	114	76	57	46	42	38	35	33	31	29	25	23	21	19			
9" G	38.5	38.20	67	67	57	46	42	38	35	33	31	29	25	23					
12" C	34.0	39.61	108	79	59	48	43	40	37	34	32	30	26	24	22	20			
12" B	31.5	40.54	79	79	61	49	44	41	37	35	32	30	27	24	22	20			
12" C	32.0	40.65	80	80	61	49	44	41	38	35	33	31	27	24	22	20			
14" C	30.0	41.82	91	84	63	50	46	42	39	36	34	31	28	25	23	21	19	18	17
14" B	30.0	42.49	88	85	64	51	46	43	39	36	34	32	28	26	23	21	20	18	17
9" G	43.5	42.85	77	77	64	51	47	43	40	37	34	32	29	26					
9" C	43.0	42.86	78	78	64	51	47	43	40	37	34	32	29	26	23	21			
12" I	40.8	44.82	132	90	67	54	49	45	41	38	36	34	30	27	24	22			
10" G	41.5	45.57	74	74	68	55	50	46	42	39	36	34	30	27	25				
12" C	36.0	45.78	90	90	69	55	50	46	42	39	37	34	31	28	25	23			
12" B	36.0	46.01	88	88	69	55	50	46	42	39	37	35	31	28	25	23			
12" I	45.0	47.35	142	95	71	57	52	47	44	41	38	36	32	28	26	24			
14" C	33.0	47.63	91	91	72	57	52	48	44	41	38	36	32	29	26	24	22	20	19
14" B	33.0	47.76	89	89	72	57	52	48	44	41	38	36	32	29	26	24	22	21	19
9" C	48.0	47.85	88	88	72	57	52	48	44	41	38	36	32	29	26	24			
10" G	44.5	49.34	77	77	74	59	54	49	46	42	39	37	33	30	27				
12" B	40.0	50.20	95	95	75	60	55	50	46	43	40	38	33	30	27	25			
12" I	50.0	50.27	151	101	75	60	55	50	46	43	40	38	34	30	27	25			
14" C	38.0	51.07	126	102	77	61	56	51	47	44	41	38	34	31	28	26	24	22	20
14" C	36.0	51.93	99	99	78	62	57	52	48	45	42	39	35	31	28	26	24	22	21
12" C	40.0	52.28	84	84	78	63	57	52	48	45	42	39	35	31	29	26			
10" C	49.0	53.20	90	90	80	64	58	53	49	46	43	40	36	32	29	27			
12" I	55 0	53.22	160	106	80	64	58	53	49	46	43	40	36	32	29	27			
15" P	36.0	54.01	104	104	81	65	59	54	50	46	43	41	36	32	30				
14" B	37.5	54.35	103	103	82	65	59	54	50	47	44	41	36	33	30	27	25	23	22
16" C	35.0	54.68	111	109	82	66	60	55	51	47	44	41	37	33	30	27	25	24	22
10" G	50.0	54.84	87	87	82	66	60	55	51	47	44	41	37	33	30				
15" B	36.0	55.12	100	100	83	66	60	55	51	47	44	41	37	33	30	28	25	24	22
16" B	35.0	55.13	108	108	83	66	60	55	51	47	44	41	37	33	30	28	25	24	22
12" B	44.0	55.30	105	105	83	66	60	55	51	47	44	41	37	33	30	28			
14" C	39 0	56.26	108	108	84	68	61	56	52	48	45	42	38	34	31	28	26	24	23
10" C	56.0	56 64	139	113	85	68	62	57	52	49	45	43	38	34	31	28			
12" C	45.0	58.85	95	95	88	71	64	59	54	50	47	44	39	35	32	29			
15" I	42.9	58 91	148	118	88	71	64	59	54	50	47	44	39	35	32	29	27	25	24
16" C	38.0	59.34	121	118	89	71	65	59	55	51	47	44	40	36	32	30	27	25	24
15" B	38.5	59 68	104	104	90	72	65	60	55	51	48	45	40	36	33	30	28	26	24
10" C	63.0	60 08	180	120	90	72	66	60	56	52	48	45	40	36	33	30			
15" I	45.0	60 48	163	121	91	73	66	60	56	52	48	45	40	36	33	30	28	26	24
14" C	42.0	60 60	117	117	91	73	66	61	56	52	49	46	40	36	33	30	28	26	24
12" B	48.5	60.93	116	116	91	73	66	61	56	52	49	46	41	37	33	30			
14" B	42.0	61.26	116	116	92	74	67	61	57	53	49	46	41	37	33	31	28	26	25
15" B	40.0	61.65	110	110	92	74	67	62	57	53	49	46	41	37	34	31	28	26	25
15" I	50.0	64.15	192	128	96	77	70	64	59	55	51	48	43	38	35	32	30	27	26
15" B	42.5	65.21	118	118	98	78	71	65	60	56	52	49	43	39	36	33	30	28	26
12" C	50.0	65.35	106	106	98	78	71	65	60	56	52	49	44	39	36	33			
16" C	40.0	65.58	111	111	98	79	72	66	61	56	52	49	44	39	36	33	30	28	26
16" C	43.0	65.75	143	132	99	79	72	66	61	56	53	49	44	40	36	33	30	28	26
16" B	40.0	65.78	113	113	99	79	72	66	61	56	53	49	44	40	36	33	30	28	26
12" G	51.5	67.27	103	103	101	81	73	67	62	58	54	50	45	40	37	34			
15" I	55.0	67.83	204	136	102	81	74	68	63	58	54	51	45	41	37	34	31	29	27
15" B	46.0	68 91	129	129	103	83	75	69	64	59	55	52	46	41	38	35	32	30	28
14" C	48.0	70.86	115	115	106	85	77	71	65	61	57	53	47	43	39	35	33	30	28
12" C	55.0	71.40	108	108	107	86	78	71	66	61	57	54	48	43	39	36			
12" G	55.5	72.60	109	109	109	87	79	73	67	62	58	54	48	44	40	36			
16" B	45.0	73.76	128	128	111	89	81	74	68	63	59	55	49	44	40	37	34	32	30
16" C	45.0	73.78	126	126	111	89	81	74	68	63	59	55	49	44	40	37	34	32	30
12" C	60.0	74 33	143	143	112	89	81	74	69	64	60	56	50	45	41	37			
15" B	50.5	75.71	137	137	114	91	83	76	70	65	61	57	50	45	41	38	35	32	30
12" C	65.0	77.28	155	155	116	93	84	77	71	66	62	58	52	46	42	39			
14" C	53.0	78.25	128	128	117	94	85	78	72	67	63	59	52	47	43	39	36	34	31
12" G	61.0	79.80	119	119	119	96	87	80	74	68	64	60	53	48	44	40			
12" C	70.0	80.20	214	160	120	96	88	80	74	69	64	60	54	48	44	40			
15" I	60.8	81.20	212	162	122	97	89	81	75	70	65	61	54	49	44	41	37	35	32
16" C	50.0	81.95	141	141	123	98	89	82	76	70	66	61	55	49	45	41	38	35	33

SUMMARY OF BEAMS FOR VARIOUS UNIFORM LOADS AND SPANS

Size and Kind	Weight per Foot	Section Modulus	SPAN IN FEET—BEAMS LATERALLY FIXED																
			6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
15″ B	54.5	82.27	148	123	99	82	71	62	55	49	45	41	38	35	33				
16″ B	50.0	82.34	142	124	99	82	71	62	55	49	45	41	38	35	33	31			
12″ G	66.0	83.65	128	126	100	84	72	63	56	50	46	42							
15″ I	65.0	84.28	169	126	101	84	72	63	56	51	46	42	39	36	34				
18″ B	47.0	85.18	140	128	102	85	73	64	57	51	47	43	39	37	34	32	30	28	
18″ C	47.0	85.40	138	128	102	85	73	64	57	51	47	43	39	37	34	32	30	28	
14″ C	58.0	85.58	141	128	103	86	73	64	57	51	47	43	40	37	34				
15″ I	70.0	87.95	176	132	106	88	75	66	59	53	48	44	41	38	35				
18″ I	54.7	88.39	177	133	106	88	76	66	59	53	48	44	41	38	35	33	31	29	
18″ B	49.0	89.20	143	134	107	89	76	67	59	54	49	45	41	38	36	33	31	30	
15″ B	59.5	89.44	163	134	107	89	77	67	60	54	49	45	41	38	36				
18″ C	51.0	89.88	162	135	108	90	77	67	60	54	49	45	41	39	36	34	32	30	
12″ G	70.5	90.60	135	135	109	91	78	68	60	54	49	45							
15″ I	75.0	91.63	183	137	110	92	79	69	61	55	50	46	42	39	37				
18″ I	60.0	93.09	186	140	112	93	80	70	62	56	51	47	43	40	37	35	33	31	
14″ C	61.0	93.12	129	129	112	93	80	70	62	56	51	47	43	40	37				
16″ B	56.5	93.49	143	140	112	94	80	70	62	56	51	47	43	40	37	35			
18″ B	52.0	94.32	154	141	113	94	81	71	63	57	51	47	44	40	38	35	33	31	
18″ C	52.0	94.41	154	142	113	94	81	71	63	57	52	47	44	40	38	35	33	31	
12″ C	75.0	96.42	140	140	116	96	83	72	64	58	53	48							
16″ C	58.0	97.08	144	144	117	97	83	73	65	58	53	49	45	42	39	36	34		
18″ I	65.0	97.53	195	146	117	98	84	73	65	59	53	49	45	42	39	37	34	32	
12″ G	76.5	98.05	148	147	118	98	84	74	65	59	54	49							
18″ B	54.5	98.91	161	148	119	99	85	74	66	59	54	49	46	42	40	37	35	33	
12″ C	83.0	101.13	196	152	121	101	87	76	67	61	55	51							
16″ B	60.5	101.51	150	150	122	102	87	76	68	61	55	51	47	44	41	38			
18″ I	70.0	101.94	204	153	122	102	87	76	68	61	56	51	47	44	41	38	36	34	
14″ C	68.0	103.78	145	145	125	104	89	78	69	62	57	52	48	45	42				
15″ G	64.5	104.13	139	139	125	104	89	78	69	63	57	52	48	45	42	39	37		
18″ C	58.0	105.28	172	158	126	105	90	79	70	63	57	53	49	45	42	39	37	35	
16″ C	63.0	105.49	157	157	127	106	90	79	70	63	58	53	49	45	42	40	37		
12″ C	91.0	105.83	212	159	127	106	91	79	71	64	58	53							
15″ B	71.5	106.60	187	160	128	107	91	80	71	64	58	53	49	46	43				
18″ B	59.0	108.20	162	162	130	108	93	81	72	65	59	54	50	46	43	41	38	36	
20″ B	56.0	109.27	179	164	131	109	94	82	73	66	60	55	50	47	44	41	39	36	35
15″ G	69.0	109.58	150	150	132	110	94	82	73	66	60	55	51	47	44	41	39	37	
16″ B	66.0	110.22	162	162	132	110	95	83	74	66	60	55	51	47	44	41			
12″ C	100.0	111.12	222	167	133	111	95	83	74	67	61	56							
16″ C	68.0	113.85	171	171	137	114	98	85	76	68	62	57	53	49	46	43	40		
14″ C	75.0	114.52	162	162	137	115	98	86	76	69	63	57	53	49	46				
20″ I	65.4	116.95	234	175	140	117	100	88	78	70	64	58	54	50	47	44	41	39	37
20″ B	59.5	118.15	180	177	142	118	101	89	79	71	64	59	55	51	47	44	42	39	37
18″ B	64.5	118.53	172	172	142	119	102	89	79	71	65	59	55	51	47	44	42	40	
15″ G	74.0	119.03	158	158	143	119	102	89	79	71	65	60	55	51	48	45	42	40	
16″ B	71.5	119.82	177	177	144	120	103	90	80	72	65	60	55	51	48	45			
21″ C	58.0	120.30	181	180	144	120	103	90	80	72	66	60	56	52	48	45	42	40	38
20″ I	70.0	121.42	243	182	146	121	104	91	81	73	66	61	56	52	49	46	43	40	38
20″ B	62.0	123.61	188	185	148	124	106	93	82	74	67	62	57	53	49	46	44	41	39
21″ C	60.0	124.08	189	186	149	124	106	93	83	74	68	62	57	53	50	47	44	41	39
18″ C	67.0	124.12	175	175	149	124	106	93	83	74	68	62	57	53	50	47	44	41	
22″ B	58.0	124.67	189	187	150	125	107	94	83	75	68	62	58	53	50	47	44	42	39
20″ I	75.0	126.35	253	190	152	126	108	95	84	76	69	63	58	54	51	47	45	42	40
18″ I	75.6	126.87	242	190	152	127	109	95	85	76	69	63	59	54	51	48	45	42	
18″ B	69.0	128.19	181	181	154	128	110	96	85	77	70	64	59	55	51	48	45	43	
20″ B	64.5	128.74	193	193	154	129	110	97	86	77	70	64	59	55	51	48	45	43	41
15″ G	80.5	129.29	174	174	155	129	111	97	86	78	71	65	60	55	52	48	46	43	
16″ G	74.5	130.18	149	149	149	130	112	98	87	78	71	65	60	56	52	49	46	43	
18″ I	80.0	130.76	262	196	157	131	112	98	87	78	71	65	60	56	52	49	46	44	
14″ C	85.0	131.61	146	146	146	132	113	99	88	79	72	66	61	56	53				
16″ C	76.0	132.66	161	161	159	133	114	100	88	80	72	66	61	57	53	50	47		
21″ C	64.0	132.85	201	199	159	133	114	100	89	80	72	66	61	57	53	50	47	44	42
18″ C	72.0	133.42	190	190	160	133	114	100	89	80	73	67	62	57	53	50	47	44	
18″ I	85.0	135.18	270	203	162	135	116	101	90	81	74	68	62	58	54	51	48	45	
22″ B	62.5	135.95	195	195	163	136	117	102	91	82	74	68	63	58	54	51	48	45	43
20″ B	68.5	137.42	196	196	165	137	118	103	92	83	75	69	63	59	55	52	49	46	43
18″ B	74.0	137.88	191	191	165	138	118	103	92	83	75	69	64	59	55	52	49	46	
18″ I	90.0	139.61	279	209	168	140	120	105	93	84	76	70	64	60	56	52	49	47	
16″ G	81.0	141.41	161	161	161	141	121	106	94	85	77	71	65	61	57	53	50	47	
18″ C	78.0	144.59	206	206	174	145	124	108	96	87	79	72	67	62	58	54	51	48	
16″ C	83.0	144.88	177	177	174	145	124	109	97	87	79	72	67	62	58	54	51		

SUMMARY OF BEAMS FOR VARIOUS UNIFORM LOADS AND SPANS

Size and Kind	Weight per Foot	Section Modulus	SPAN IN FEET—BEAMS LATERALLY FIXED																
			10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
21″ C	70.0	145.23	174	145	124	109	97	87	79	73	67	62	58	54	51	48	46	44	41
20″ I	81.4	146.63	176	147	126	110	98	88	80	73	68	63	59	55	52	49	46	44	
14″ C	95.0	147.19	165	147	126	110	98	88	80	74	68	63	59						
15″ G	94.0	147.32	177	147	126	111	98	88	80	74	68	63	59	55	52				
22″ B	67.5	148.06	178	148	127	111	99	89	81	74	68	63	59	56	52	49	46	44	42
20″ B	73.0	148.50	178	149	127	111	99	89	81	74	69	64	59	56	52	50	47	45	
20″ I	85.0	150.17	180	150	129	113	100	90	82	75	69	64	60	56	53	50	47	45	
16″ G	87.0	152.70	174	153	131	115	102	92	83	76	71	65	61	57	54	51			
15″ G	99.0	154.26	185	154	132	116	103	93	84	77	71	66	62	58	54	51			
18″ G	80.0	154.44	180	154	132	116	103	93	84	77	71	66	62	58	55	51	49	46	
20″ I	90.0	155.03	186	155	133	116	103	93	85	78	72	66	62	58	55	52	49	47	
16″ C	90.0	157.08	189	157	135	118	105	94	86	79	73	67	63	59	55				
20″ B	78.0	157.84	189	158	135	118	105	95	86	79	73	68	63	59	56	53	50	47	
20″ I	95.0	159.97	192	160	137	120	107	96	87	80	74	69	64	60	56	53	50	48	
22″ B	73.0	161.50	194	162	138	121	108	97	88	81	75	69	65	61	57	54	51	48	46
14″ C	105.0	162.78	185	163	140	122	109	98	89	81	75	70	65						
24″ C	70.0	162.82	195	163	140	122	109	98	89	81	75	70	65	61	57	54	51	49	47
24″ B	70.0	163.66	196	164	140	123	109	98	89	82	76	70	66	61	58	55	52	49	47
15″ G	105.0	164.17	197	164	141	123	109	99	90	82	76	70	66	62	58	55			
20″ I	100.0	164.83	198	165	141	124	110	99	90	82	76	71	66	62	58	55	52	49	
16″ G	94.0	165.10	189	165	142	124	110	99	90	83	76	71	66	62	58	55			
18″ G	86.0	167.07	190	167	143	125	111	100	91	84	77	72	67	63	59	56	53	50	
18″ C	86.0	168.23	185	168	144	126	112	101	92	84	78	72	67	63	59	56			
22″ B	77.0	170.63	205	171	146	128	114	102	93	85	79	73	68	64	60	57	54	51	49
21″ C	80.0	170.90	205	171	146	128	114	103	93	85	79	73	68	64	60	57	54	51	49
24″ I	79.9	173.93	209	174	149	130	116	104	95	87	80	74	70	65	61	58	55	52	50
15″ G	111.0	174.51	209	175	150	131	116	105	95	87	81	75	70	65	62	58			
24″ B	73.5	175.73	211	176	151	132	117	105	96	88	81	75	70	66	62	59	55	53	50
16″ C	100.0	178.35	178	178	153	134	119	107	97	89	82	76	71	67	63				
18″ G	92.0	179.75	200	180	154	135	120	108	98	90	83	77	72	67	63	60	57	54	
24″ I	85.0	180.00	216	180	154	135	120	108	98	90	83	77	72	68	63	60	57	54	51
18″ C	93.0	181.94	201	182	156	136	121	109	99	91	84	78	73	68	64	61			
24″ C	76.0	182.03	218	182	156	137	121	109	99	91	84	78	73	68	64	61	57	55	52
21″ C	86.0	183.65	220	184	157	138	122	110	100	92	85	79	73	69	65	61	58	55	52
22″ B	83.0	184.23	221	184	158	138	123	111	101	92	85	79	74	69	65	61	58	55	53
24″ I	90.0	185.84	223	186	159	139	124	111	101	93	86	80	74	70	66	62	59	56	53
24″ B	79.5	188.19	226	188	161	141	125	113	103	94	87	81	75	71	66	63	59	56	54
16″ C	107.0	190.84	192	191	164	143	127	114	104	95	88	82	76	72	67				
24″ I	95.0	191.80	230	192	164	144	128	115	105	96	89	82	77	72	68	64	61	58	55
15″ G	127.0	191.95	230	192	165	144	128	115	105	96	89	82	77	72	68				
18″ G	99.0	193.72	212	194	166	145	129	116	106	97	89	83	77	73	68	65	61	58	
18″ C	100.0	195.57	218	196	168	147	130	117	107	98	90	84	78	73	69	65			
21″ C	92.0	196.46	236	196	168	147	131	118	107	98	91	84	79	74	69	65	62	59	56
24″ I	100.0	197.65	237	198	169	148	132	119	108	99	91	85	79	74	70	66	62	59	56
22″ B	89.0	197.88	237	198	170	148	132	119	108	99	91	85	79	74	70	66	63	59	57
24″ B	84.5	200.48	241	201	172	150	134	120	109	100	93	86	80	75	71	67	63	60	57
26″ B	81.0	201.71	242	202	173	151	135	121	110	101	93	87	81	76	71	67	64	61	58
15″ G	135.0	202.94	243	203	174	152	135	122	111	101	94	87	81	76	72	68			
24″ C	85.0	203.46	244	203	174	153	136	122	111	102	94	87	81	76	72	68	64	61	58
16″ C	115.0	205.17	207	205	176	154	137	123	112	103	95	88	82	77	72				
20″ G	99.0	206.02	242	206	177	155	137	124	112	103	95	88	82	77	73	69	65	62	
15″ G	141.0	212.91	255	213	182	160	142	128	116	106	98	91	85	80	75	71			
22″ B	96.5	213.37	256	213	183	160	142	128	116	107	99	91	85	80	75	71	67	64	61
26″ B	85.5	214.26	257	214	184	161	143	129	117	107	99	92	86	80	76	72	68	64	61
24″ B	90.5	214.61	258	215	184	161	143	129	117	107	99	92	86	81	76	72	68	64	61
20″ G	107.0	221.98	258	222	190	167	148	133	121	111	102	95	89	83	78	74	70	67	
15″ G	147.0	222.94	267	223	191	167	149	134	122	111	103	96	89	84	79	74			
24″ C	94.0	225.02	270	225	193	169	150	135	123	113	104	96	90	84	79	75	71	68	64
24″ B	95.5	225.24	270	225	193	169	150	135	123	113	104	97	90	84	79	75	71	68	64
26″ B	91.0	230.24	276	230	197	173	153	138	126	115	106	99	92	86	81	77	73	69	66
24″ I	105.9	234 30	234	234	201	176	156	141	128	117	108	100	94	88	83	78	74	70	
21″ C	104.0	235.74	234	234	202	177	157	141	129	118	109	101	94	88	83	79	74	71	
20″ G	113.0	236.28	269	236	203	177	158	142	129	118	109	101	95	89	83	79	75	71	
22″ G	101.0	236.78	284	236	203	178	158	142	129	118	109	101	95	89	84	79	75	71	68
24″ B	99.5	236.78	284	237	203	178	158	142	129	118	109	101	95	89	84	79	75	71	68
27″ C	91.0	238.30	286	238	204	179	159	143	130	119	110	102	95	89	84	79	75	71	68
24″ I	110.0	239.10	287	239	205	179	159	143	130	120	110	102	96	90	84	80	76	72	68
24″ I	115.0	245.04	294	245	210	184	163	147	134	123	113	105	98	92	86	82	77	74	72
28″ B	91.0	246.85	296	247	212	185	165	148	135	123	114	106	99	93	87	82	78	74	71
26″ B	98.0	247.41	297	247	212	186	165	148	135	124	114	106	99	93	87	82	78	74	71
24″ B	104.5	248.84	299	249	213	187	166	149	136	124	115	107	100	93	88	83	79	75	71
24″ I	120.0	250.90	301	251	215	188	167	151	137	125	116	108	100	94	89	84	79	75	72
20″ G	120.0	251.29	285	251	215	188	168	151	137	126	116	108	100	94	89	84	79	75	

SUMMARY OF BEAMS FOR VARIOUS UNIFORM LOADS AND SPANS

Size and Kind	Weight per Foot	Section Modulus	SPAN IN FEET—BEAMS LATERALLY FIXED																
			12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	45	50
24″ C	100.0	251.71	252	216	189	168	151	137	126	116	108	101	94	89	84	79	76	67	60
21″ C	112.0	254.07	253	218	191	169	152	139	127	117	109	102	95	90	85	80	76		
22″ G	108.0	254.94	253	219	191	170	153	139	128	118	109	102	96	90	85	81	77		
20″ G	127.0	264.03	264	226	198	176	158	144	132	122	113	106	99	93	88	83	79		
27″ C	101.0	264.72	265	227	199	176	159	144	132	122	113	106	99	93	88	84	79	71	64
28″ B	97.0	265.11	265	227	199	177	159	145	133	122	114	106	99	94	88	84	80	71	64
24″ G	107.0	266.87	267	229	200	178	160	146	133	123	114	107	100	94	89	84	80	71	64
21″ C	120.0	272.11	272	233	204	181	163	148	136	126	117	109	102	96	91	86	82		
22″ G	116.0	273.16	271	234	205	182	164	149	137	126	117	109	102	96	91	86	82		
24″ C	110.0	276.83	277	237	208	185	166	151	138	128	119	111	104	98	92	87	83	74	66
20″ G	135.0	280.57	281	240	210	187	168	153	140	130	120	112	105	99	94	89	84		
24″ G	113.0	281.68	282	241	211	188	169	154	141	130	121	113	106	99	94	89	85	75	68
28″ B	104.0	284.73	285	244	214	190	171	155	142	131	122	114	107	100	95	90	85	76	68
27″ C	112.0	293.17	293	251	220	195	176	160	147	135	126	117	110	103	98	93	88	78	70
22″ G	124.0	293.19	291	251	220	195	176	160	147	135	126	117	110	104	98	93	88		
20″ G	142.0	296.06	296	254	222	197	178	162	148	137	127	118	111	105	99	94	89		
24″ G	120.0	300.65	301	258	225	200	180	164	150	139	129	120	113	106	100	95	90	80	72
24″ C	120.0	301.91	302	259	226	201	181	165	151	139	129	121	113	107	101	95	91	81	72
28″ B	112.0	306.41	306	263	230	204	184	167	153	141	131	123	115	108	102	97	92	82	74
20″ G	149.0	311.62	312	267	234	208	187	170	156	144	134	125	117	110	104	98	93		
30″ B	110.0	314.82	315	270	236	210	189	172	157	145	135	126	118	111	105	99	95	84	76
24″ G	128.0	320.66	321	275	240	214	192	175	160	148	137	128	120	113	107	101	96	86	77
27″ C	124.0	324.82	325	278	244	217	195	177	162	150	139	130	122	115	108	103	97	87	78
24″ G	132.0	329.95	327	283	247	220	198	180	165	152	141	132	124	116	110	104	99	88	79
30″ B	115.0	330.85	331	284	248	221	198	180	165	153	142	132	124	117	110	104	99	88	79
30″ C	115.0	332.35	332	285	249	222	199	181	166	153	142	133	125	117	111	105	100	89	80
24″ C	130.0	333.62	318	286	250	222	200	182	167	154	143	133	125	118	111	105	100	89	80
24″ G	140.0	350.11	346	300	263	233	210	191	175	162	150	140	131	124	117	111	105	93	84
30″ B	121.0	351.31	351	301	263	234	211	192	176	162	151	141	132	124	117	111	105	94	85
27″ C	137.0	358.73	352	302	264	235	211	192	176	163	151	141	132	124	117	111	106	96	85
24″ C	140.0	359.23	344	308	269	239	216	196	180	166	154	144	135	127	120	113	108	96	86
30″ C	126.0	363.82	364	312	273	243	218	198	182	168	156	145	136	128	121	115	109	97	37
26″ G	138.0	370.39	359	317	278	247	222	202	185	171	159	148	139	131	124	117	111	99	89
24″ G	148.0	371.31	370	318	278	248	223	203	186	171	159	149	139	131	124	117	111	99	89
30″ B	129.0	373.35	373	320	280	249	224	204	187	172	160	149	140	132	124	118	112	100	90
24″ C	150.0	384.94	370	330	289	257	231	210	192	178	165	154	144	136	128	122	115	103	92
26″ G	144.0	385.12	379	330	289	257	231	210	193	178	165	154	144	136	128	122	116	103	92
33″ B	125.0	394.32	394	338	296	263	237	215	197	182	169	158	148	139	131	125	118	105	95
30″ C	138.0	398.73	399	342	299	266	239	217	199	184	171	159	150	141	133	126	120	106	96
26″ G	151.0	406.91	393	349	305	271	244	222	203	188	174	163	153	144	136	128	122	109	98
27″ C	145.0	408.05	376	350	306	272	245	223	204	188	175	163	153	144	136	129	122	109	98
24″ C	160.0	410.78	397	352	308	274	246	224	205	190	176	164	154	145	137	130	123	110	99
28″ G	145.0	416.02	390	357	312	277	250	227	208	192	178	166	156	147	139	131	125	111	100
33″ B	135.0	422.27	422	362	317	282	253	230	211	195	181	169	158	149	141	133	127	113	101
26″ G	160.0	431.04	420	369	323	287	259	235	215	199	185	172	162	152	144	136	129	115	103
30″ C	151.0	436.42	436	374	327	291	262	238	218	201	187	175	164	154	145	138	131	116	105
28″ G	156.0	446.10	425	382	335	297	268	243	223	206	191	178	167	157	149	141	134	119	107
33″ B	143.0	449.41	449	385	337	300	270	245	225	207	193	180	169	159	150	142	135	120	108
27″ C	160.0	450.13	417	386	338	300	270	246	225	208	193	180	169	159	150	142	135	120	108
28″ G	165.0	473.19	454	406	355	315	284	258	237	218	203	189	177	167	158	149	142	126	114
30″ C	165.0	476.66	477	409	358	318	286	260	238	220	204	191	179	168	159	151	143	127	114
33″ B	152.0	478.40	478	410	359	319	287	261	239	221	205	191	179	169	160	151	144	128	115
27″ C	175.0	492.47	459	422	369	328	295	269	246	227	211	197	185	174	164	156	148	131	118
28″ G	175.0	499.72	479	428	375	333	300	273	250	231	214	200	187	176	167	158	150	133	120
36″ B	147.0	500.90	501	429	376	334	301	273	250	231	215	200	188	177	167	158	150	134	120
30″ G	173.0	528.46	473	453	396	352	317	288	264	244	226	211	198	187	176	167	159	141	127
36″ B	155.0	530.41	530	455	398	354	318	289	265	245	227	212	199	187	177	167	159	141	127
27″ C	190.0	534.60	501	458	401	356	321	292	267	247	229	214	200	189	178	169	160	143	128
30″ C	180.0	553.43	482	474	415	369	332	302	277	255	237	221	208	195	184	175	166	148	133
30″ G	180.0	556.21	490	477	417	371	334	303	278	257	238	222	209	196	185	176	167	148	133
36″ B	164.0	561.07	559	481	421	374	337	306	281	259	240	224	210	198	187	177	168	150	135
30″ G	190.0	585.52	513	502	439	390	351	319	293	270	251	234	220	207	195	185	176	156	141
36″ B	173.0	594.98	592	510	446	397	357	325	297	275	255	238	223	210	198	188	178	159	143
30″ C	200.0	614.99	540	527	461	410	369	335	307	284	264	246	231	217	205	194	184	164	148
30″ G	200.0	617.77	541	530	463	412	371	337	309	285	265	247	232	218	206	195	185	165	148
33″ G	202.0	676.03	568	568	507	451	406	369	338	312	290	270	254	239	225	213	203	180	162
30″ C	220.0	676.26	598	580	507	451	406	369	338	312	290	271	254	239	225	214	203	180	162
33″ G	210.0	707.33	582	582	531	472	424	386	354	326	303	283	265	250	236	223	212	189	170
30″ C	240.0	737.86	656	632	553	492	443	402	369	341	316	295	277	260	246	233	221	197	177
33″ G	220.0	741.43	608	608	556	494	445	404	371	342	318	297	278	262	247	234	222	198	178
33″ G	230.0	778.05	634	634	584	519	467	424	389	359	333	311	292	275	259	246	233	207	187
36″ G	231.0	834.95	663	663	626	557	501	455	417	385	358	334	313	295	278	264	250	223	200
36″ G	240.0	872.00	683	683	654	581	523	476	436	402	374	349	327	308	291	275	262	233	209
36″ G	250.0	911.24	711	711	683	607	547	497	455	420	390	364	342	322	304	288	273	243	219
36″ G	260.0	949.50	735	735	712	633	570	518	475	438	407	380	356	335	316	300	285	253	228

LOADS BY A. I. S. C. SPECIFICATION

Part IV

Section 10

Bethlehem Columns

Bethlehem Columns with Cover Plates

Dimensions

Technical Functions

Allowable Concentric Loads

by

A. I. S. C. Specification

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 6" AND 8" ROLLED COLUMNS

BETHLEHEM SECTIONS

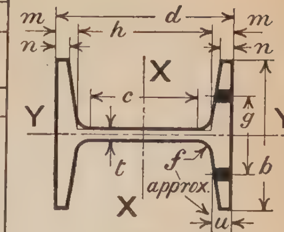
Weight per foot	Area Sq. In.	Least Radius Gyration	UNSUPPORTED LENGTH IN FEET																			
			4	6	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30
6" BETHLEHEM STANCHIONS.																						
15.5	4.61	1.41	69	69	66	63	59	56	53	49	46	44	41	38	36							
18.0	5.33	1.43	80	80	77	73	69	65	61	58	54	51	48	45	42							
20.5	6.06	1.45	91	91	88	83	79	75	70	66	62	59	55	49	49							
6" BETHLEHEM H COLUMNS.																						
20.0	5.89	1.49	88	88	86	82	78	74	70	66	62	59	55	52	49	46	43	39	35			
23.0	6.76	1.51	101	101	99	95	90	85	81	76	72	68	64	60	57	54	51	45	40			
26.5	7.76	1.53	116	116	115	109	104	99	94	89	84	79	74	70	66	63	59	53	47			
30.0	8.77	1.54	132	132	130	124	118	112	106	101	95	90	85	80	75	71	67	60	54			
33.5	9.80	1.55	147	147	145	139	132	126	119	113	107	101	95	90	85	80	76	67	60			
37.0	10.83	1.57	162	162	161	154	147	140	133	126	119	113	106	101	95	90	85	76	68			
40.5	11.87	1.58	178	178	177	170	162	154	146	139	131	124	117	111	105	99	94	84	75			
8" BETHLEHEM BEAMS																						
17.5	5.20	1.11	78	76	66	61	57	52	48	45	41	38	35	33	30							
19.0	5.68	1.13	85	83	73	68	63	58	54	50	46	42	39	36	34							
8" BETHLEHEM GIRDER BEAMS																						
29.5	8.69	1.81	130	130	130	130	126	121	116	111	106	101	96	92	87	83	79	71	65	59	53	
33.0	9.69	1.86	145	145	145	145	141	136	131	125	120	115	110	105	100	95	91	82	75	68	62	
36.5	10.81	1.90	162	162	162	162	159	154	148	142	136	130	124	119	113	108	103	94	86	78	71	
8" BETHLEHEM H COLUMNS.																						
23.5	6.85	1.57	103	103	102	98	93	89	84	80	75	71	67	64	60	57	54	48	43			
27.0	7.89	1.59	118	118	118	113	108	103	98	93	88	83	78	74	70	66	63	56	50			
30.5	8.95	1.61	134	134	134	129	123	117	112	106	100	95	90	85	81	76	72	65	58			
34.5	10.10	1.62	152	152	152	146	139	133	126	120	114	108	102	97	91	87	82	74	66	59		
32.0	9.30	1.96	140	140	140	140	139	134	129	124	119	114	109	105	100	96	91	83	76	70	64	58
35.0	10.30	2.00	155	155	155	155	155	149	144	139	133	128	123	117	113	108	103	94	86	79	72	66
39.5	11.63	2.01	174	174	174	174	174	169	163	157	151	145	139	133	128	122	117	107	98	89	82	75
44.0	12.96	2.03	194	194	194	194	194	189	182	176	169	162	156	149	143	137	131	120	110	101	93	85
48.5	14.31	2.04	215	215	215	215	215	209	202	194	187	180	173	166	159	152	146	133	122	112	103	94
53.0	15.66	2.06	235	235	235	235	235	230	222	214	206	198	190	182	175	168	161	147	135	124	114	105
58.0	17.03	2.07	255	255	255	255	255	250	242	233	224	216	207	199	191	183	175	161	148	134	124	114
62.5	18.40	2.09	276	276	276	276	276	271	262	253	244	235	225	217	208	199	191	176	161	148	136	125
67.5	19.79	2.10	297	297	297	297	297	292	282	273	263	253	243	234	224	215	206	190	174	160	147	135
72.0	21.18	2.11	318	318	318	318	318	313	303	292	282	271	261	251	241	231	222	204	187	172	158	146
77.0	22.59	2.12	339	339	339	339	339	335	324	313	301	290	279	269	258	248	238	218	201	185	170	156
81.5	23.91	2.14	359	359	359	359	359	355	344	332	321	309	297	286	275	264	253	233	215	197	181	167
86.0	25.33	2.15	380	380	380	380	380	377	365	353	340	328	316	304	292	281	269	248	228	210	194	178
91.0	26.77	2.16	402	402	402	402	402	399	386	374	361	348	335	322	310	298	286	263	242	223	206	190

Loads to right of heavy vertical lines are for Secondary Members ONLY.

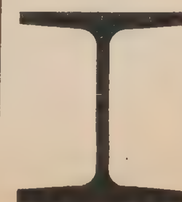
DIMENSIONS AND FUNCTIONS OF 6″ AND 8″ ROLLED COLUMNS

BETHLEHEM SECTIONS

Weight per foot	DIMENSIONS d	b	t	h	m	n	f	c	g	u	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
6″ BETHLEHEM STANCHIONS																	
15.5	6.000	6.00	.240	5.404	.298	.240	.30	5.375	3½	9/32	¾	30.3	10.10	2.56	9.19	3.06	1.41
18.0	6.094	6.03	.270	5.404	.343	.285	.30	5.375	3½	5/16	¾	35.8	11.75	2.59	11.0	3.64	1.43
20.5	6.188	6.06	.300	5.404	.388	.330	.30	5.375	3½	11/32	¾	41.5	13.41	2.62	12.8	4.23	1.45
6″ BETHLEHEM H COLUMNS																	
20.0	6.000	6.000	.250	5.193	.404	.346	.30	4.625	3½	⅜	¾	39.1	13.03	2.58	13.0	4.34	1.49
23.0	6.125	6.020	.270	5.193	.466	.409	.30	4.625	3½	7/16	¾	46.4	15.15	2.62	15.4	5.12	1.51
26.5	6.250	6.060	.310	5.193	.529	.471	.30	4.625	3½	½	¾	54.4	17.41	2.65	18.1	5.96	1.53
30.0	6.375	6.100	.350	5.193	.591	.534	.30	4.625	3½	9/16	¾	62.8	19.70	2.68	20.8	6.82	1.54
33.5	6.500	6.140	.390	5.193	.654	.596	.30	4.625	3½	⅝	¾	71.6	22.03	2.70	23.6	7.70	1.55
37.0	6.625	6.180	.430	5.193	.716	.659	.30	4.625	3½	11/16	¾	80.9	24.42	2.73	26.6	8.60	1.57
40.5	6.750	6.220	.470	5.193	.779	.721	.30	4.625	3½	¾	¾	90.5	26.81	2.76	29.6	9.52	1.58
8″ BETHLEHEM BEAMS																	
17.5	8.000	5.250	.250	7.164	.418	.210	.30	6.625	2¼	11/32	¾	57.7	14.43	3.33	6.39	2.44	1.11
19.0	8.060	5.270	.270	7.164	.448	.240	.30	6.625	2¼	⅜	¾	62.9	15.60	3.35	7.20	2.73	1.13
8″ BETHLEHEM GIRDER BEAMS																	
29.5	7.880	7.995	.285	6.738	.571	.250	.40	6.000	5½	11/32	⅞	100.7	25.56	3.41	28.4	7.10	1.81
33.0	8.000	8.000	.290	6.738	.631	.310	.40	6.000	5½	13/32	⅞	116.1	29.03	3.46	33.6	8.39	1.86
36.5	8.120	8.020	.310	6.738	.691	.370	.40	6.000	5½	15/32	⅞	132.6	32.66	3.50	39.0	9.72	1.90
8″ BETHLEHEM H COLUMNS																	
23.5	7.750	6.500	.250	6.923	.413	.351	.40	6.125	3½	⅜	⅞	76.1	19.6	3.33	16.8	5.18	1.57
27.0	7.875	6.530	.280	6.923	.476	.413	.40	6.125	3½	7/16	⅞	89.7	22.8	3.37	20.0	6.11	1.59
30.5	8.000	6.560	.310	6.923	.538	.476	.40	6.125	3½	½	⅞	103.8	26.0	3.41	23.2	7.07	1.61
34.5	8.125	6.600	.350	6.923	.601	.538	.40	6.125	3½	9/16	⅞	118.9	29.3	3.43	26.6	8.07	1.62
32.0	7.875	8.000	.310	6.923	.476	.399	.40	6.125	5½	7/16	⅞	107.2	27.2	3.40	35.8	8.95	1.96
35.0	8.000	8.000	.310	6.923	.538	.462	.40	6.125	5½	½	⅞	123.0	30.7	3.46	41.1	10.28	2.00
39.5	8.125	8.040	.350	6.923	.601	.524	.40	6.125	5½	9/16	⅞	141.0	34.7	3.48	47.2	11.74	2.01
44.0	8.250	8.080	.390	6.923	.663	.587	.40	6.125	5½	⅝	⅞	159.7	38.7	3.51	53.4	13.22	2.03
48.5	8.375	8.120	.430	6.923	.726	.649	.40	6.125	5½	11/16	⅞	179.2	42.8	3.54	59.8	14.73	2.04
53.0	8.500	8.160	.470	6.923	.788	.712	.40	6.125	5½	¾	⅞	199.3	46.9	3.57	66.4	16.27	2.06
58.0	8.625	8.200	.510	6.923	.851	.774	.40	6.125	5½	13/16	⅞	220.1	51.0	3.60	73.1	17.83	2.07
62.5	8.750	8.240	.550	6.923	.913	.837	.40	6.125	5½	⅞	⅞	241.7	55.2	3.62	80.0	19.42	2.09
67.5	8.875	8.280	.590	6.923	.976	.899	.40	6.125	5½	15/16	⅞	264.0	59.5	3.65	87.2	21.06	2.10
72.0	9.000	8.320	.630	6.923	1.038	.962	.40	6.125	5½	1	⅞	287.1	63.8	3.68	94.5	22.72	2.11
77.0	9.125	8.360	.670	6.923	1.101	1.024	.40	6.125	5½	1 1/16	⅞	311.0	68.2	3.71	102.0	24.40	2.12
81.5	9.250	8.390	.700	6.923	1.163	1.087	.40	6.125	5½	1 ⅛	⅞	335.0	72.4	3.74	109.2	26.03	2.14
86.0	9.375	8.430	.740	6.923	1.226	1.149	.40	6.125	5½	1 3/16	⅞	360.5	76.9	3.77	117.1	27.78	2.15
91.0	9.500	8.470	.780	6.923	1.288	1.212	.40	6.125	5½	1 ¼	⅞	386.8	81.4	3.80	125.1	29.54	2.16



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration



6″ & 8″

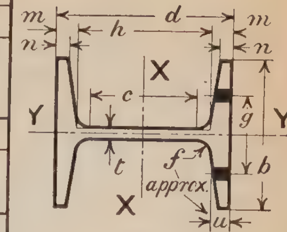
ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 10" ROLLED COLUMNS BETHLEHEM SECTIONS

Weight per Foot	Area Sq. In.	Least Radius Gyration	UNSUPPORTED LENGTH IN FEET 6	7	8	9	10	12	14	16	18	20	22	24	26	28	30
10" BETHLEHEM Bs.																	
21.0	6.28	1.22	94	89	84	79	73	64	55	48	41	36					
23.5	6.96	1 25	104	100	94	89	83	72	63	54	47	41					
26.0	7.68	1.28	115	112	105	99	93	81	71	61	54	47					
28.5	8.41	1.30	126	123	116	109	103	90	78	68	60	52					
10" BETHLEHEM Gs.																	
41.5	12.23	2.07	183	183	183	183	183	174	161	149	137	126	116	106	97	89	82
44.5	13.14	2.10	197	197	197	197	197	188	174	161	149	137	126	116	106	98	90
50.0	14.62	2.13	219	219	219	219	219	210	196	181	168	154	142	131	120	110	102
10" BETHLEHEM H COLUMNS.																	
33.5	9.80	1.93	147	147	147	147	145	135	124	114	104	95	86	79	71	66	
38.0	11.09	1.96	166	166	166	166	165	154	142	130	119	109	99	91	83	76	
42.5	12.49	1.97	187	187	187	187	186	173	160	147	135	123	113	103	94	86	79
47.5	13.90	1.99	209	209	209	209	208	194	179	165	151	138	126	116	106	97	89
49.5	14.57	2.47	219	219	219	219	219	219	209	196	184	172	160	149	139	129	120
55.0	16.12	2.50	242	242	242	242	242	242	232	219	205	192	179	167	156	145	135
60.5	17.77	2.51	267	267	267	267	267	267	256	241	227	212	198	185	172	160	149
66.0	19.44	2.53	292	292	292	292	292	292	281	265	249	233	218	203	190	177	165
72.0	21.11	2.54	317	317	317	317	317	317	306	288	271	254	237	222	207	193	180
77.5	22.80	2.56	342	342	342	342	342	342	331	313	294	276	258	241	225	210	196
83.5	24.49	2.57	367	367	367	367	367	367	356	336	317	297	278	260	242	226	211
89.0	26.20	2.59	393	393	393	393	393	393	382	361	340	319	299	280	261	244	225
95.0	27.91	2.60	419	419	419	419	419	419	408	386	363	341	319	299	279	261	243
100.5	29.53	2.61	443	443	443	443	443	443	432	409	385	362	339	317	296	277	258
106.5	31.26	2.63	469	469	469	469	469	469	459	434	409	385	361	338	316	295	276
112.0	33.00	2.64	495	495	495	495	495	495	485	459	427	407	382	358	335	313	292
118.0	34.76	2.65	521	521	521	521	521	521	511	484	457	430	403	378	354	331	309
124.0	36.52	2.66	548	548	548	548	548	548	538	510	481	453	425	398	373	348	326
130.0	38.30	2.68	575	575	575	575	575	575	566	536	507	477	448	420	393	368	344
136.5	40.08	2.69	601	601	601	601	601	601	593	562	531	500	470	441	413	386	362

Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 10″ ROLLED COLUMNS BETHLEHEM SECTIONS

Weight per Foot	DIMENSIONS											AXIS X-X			AXIS Y-Y		
	d	b	t	h	m	n	f	c	g	u	Rivet	I	S	r	I	S	r
10″ BETHLEHEM Bs.																	
21.0	9.90	5.740	.240	8.972	.464	.235	.30	8.375	2¾	11/32	⅞	108.1	21.84	4.15	9.3	3.24	1.22
23.5	10.00	5.750	.250	8.972	.514	.285	.30	8.375	2¾	13/32	⅞	123.2	24.64	4.21	10.9	3.80	1.25
26.0	10.09	5.770	.270	8.972	.559	.330	.30	8.375	2¾	15/32	⅞	137.9	27.33	4.24	12.5	4.33	1.28
28.5	10.19	5.785	.285	8.972	.609	.380	.30	8.375	2¾	½	⅞	154.1	30.25	4.28	14.2	4.92	1.30
10″ BETHLEHEM Gs.																	
41.5	9.91	8.990	.310	8.506	.702	.340	.40	7.750	5½	½	⅞	225.8	45.57	4.30	52.6	11.7	2.07
44.5	10.00	9.000	.320	8.506	.747	.385	.40	7.750	5½	9/16	⅞	246.7	49.34	4.33	58.2	12.9	2.10
50.0	10.12	9.040	.360	8.506	.807	.445	.40	7.750	5½	⅝	⅞	277.5	54.84	4.36	66.4	14.7	2.13
10″ BETHLEHEM H COLUMNS																	
33.5	9.625	8.00	.28	8.653	.486	.408		7.688	5½	7/16	⅞	169.9	35.30	4.16	36.6	9.15	1.93
38.0	9.750	8.03	.31	8.653	.548	.471		7.688	5½	½	⅞	195.6	40.12	4.20	42.4	10.56	1.96
42.5	9.875	8.07	.35	8.653	.611	.533		7.688	5½	9/16	⅞	223.0	45.16	4.23	48.5	12.02	1.97
47.5	10.000	8.11	.39	8.653	.673	.596		7.688	5½	⅝	⅞	251.3	50.26	4.25	54.8	13.51	1.99
49.5	9.875	9.97	.36	8.653	.611	.514		7.688	5½	9/16	⅞	267.2	54.1	4.28	89.1	17.9	2.47
55.0	10.000	10.00	.39	8.653	.673	.577		7.688	5½	⅝	⅞	300.4	60.1	4.32	100.4	20.1	2.50
60.5	10.125	10.04	.43	8.653	.736	.639		7.688	5½	11/16	⅞	335.5	66.3	4.34	112.2	22.3	2.51
66.0	10.250	10.08	.47	8.653	.798	.702		7.688	5½	¾	⅞	371.7	72.5	4.37	124.2	24.6	2.53
72.0	10.375	10.12	.51	8.653	.861	.764		7.688		13/16	⅞	408.9	78.8	4.40	136.5	27.0	2.54
77.5	10.500	10.16	.55	8.653	.923	.827		7.688	5½	⅞	⅞	447.2	85.2	4.43	149.1	29.4	2.56
83.5	10.625	10.20	.59	8.653	.986	.889		7.688	5½	15/16	⅞	486.6	91.6	4.46	162.0	31.8	2.57
89.0	10.750	10.24	.63	8.653	1.048	.952		7.688	5½	1″	⅞	527.2	98.1	4.49	175.2	34.2	2.59
95.0	10.875	10.28	.67	8.653	1.111	1.014		7.688	5½	1 1/16	⅞	568.9	104.6	4.51	188.6	36.7	2.60
100.5	11.000	10.31	.70	8.653	1.173	1.077		7.688	5½	1 ⅛	⅞	610.6	111.0	4.55	201.7	39.1	2.61
106.5	11.125	10.35	.74	8.653	1.236	1.139		7.688	5½	1 3/16	⅞	654.7	117.7	4.58	215.7	41.7	2.63
112.0	11.250	10.39	.78	8.653	1.298	1.202		7.688	5½	1 ¼	⅞	699.9	124.4	4.60	229.9	44.3	2.64
118.0	11.375	10.43	.82	8.653	1.361	1.264		7.688	5½	1 5/16	⅞	746.3	131.2	4.63	244.5	46.9	2.65
124.0	11.500	10.47	.86	8.653	1.423	1.327		7.688	5½	1 ⅜	⅞	794.0	138.1	4.66	259.4	49.5	2.66
130.0	11.625	10.51	.90	8.653	1.486	1.389		7.688	5½	1 7/16	⅞	843.0	145.0	4.69	274.5	52.2	2.68
136.5	11.750	10.55	.94	8.653	1.548	1.452		7.688	5½	1 ½	⅞	893.3	152.1	4.72	290.0	55.0	2.69



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

10″

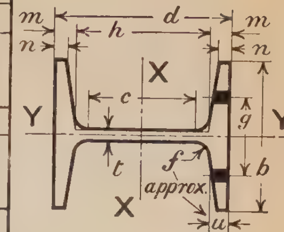
ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 12" ROLLED COLUMNS BETHLEHEM SECTIONS

Weight per Foot	Area Sq. In.	Least Radius Gyration	Unsupported Length in Feet: 4	8	12	14	16	18	20	22	24	26	28	30	32	34	36
12" BETHLEHEM Bs.																	
28.0	8.28	1.41	124	118	94	83	73	65	57	51							
36.0	10.58	1.46	159	154	124	110	97	86	76	68	60						
40.0	11.80	1.53	177	174	142	127	113	101	90	80	72						
48.5	14.28	1.57	214	213	175	157	140	125	112	100	90						
12" BETHLEHEM Gs.																	
55.5	16.35	2.28	245	245	241	226	211	196	182	169	156	144	134	123			
61.0	17.92	2.31	269	269	265	249	233	217	202	187	173	160	148	137	127		
70.5	20.79	2.40	312	312	312	294	276	258	241	224	208	193	179	166	154		
76.5	22.50	2.42	338	338	338	319	300	281	262	244	227	210	196	182	169		
12" BETHLEHEM H COLUMNS.																	
40.5	11.85	1.90	178	178	162	149	136	124	113	103	94	85	78				
45.5	13.31	1.92	200	200	183	168	154	141	128	117	106	97	89				
50.5	14.79	1.93	222	222	203	187	172	157	143	131	119	109	99				
55.0	16.27	1.94	244	244	224	207	190	173	158	144	132	120	110				
52.5	15.40	2.44	231	231	231	219	206	193	180	168	156	145	135	126	117	109	
58.0	17.12	2.45	257	257	257	244	230	215	201	187	174	162	151	140	130	121	
64.0	18.85	2.47	283	283	283	270	254	238	223	208	193	180	167	156	145	135	
70.0	20.59	2.49	309	309	309	296	279	261	244	228	213	198	184	172	160	149	
65.5	19.29	2.96	289	289	289	289	281	268	254	241	228	215	202	191	179	169	159
72.5	21.25	2.98	319	319	319	319	311	296	281	266	252	238	224	211	199	187	176
79.0	23.23	2.99	348	348	348	348	340	324	308	292	276	261	246	232	218	206	194
85.5	25.21	3.01	378	378	378	378	370	353	335	318	301	284	268	253	238	225	212
92.5	27.21	3.03	408	408	408	408	400	382	363	345	326	308	291	275	259	244	230
99.5	29.21	3.04	438	438	438	438	430	411	391	371	351	332	313	296	279	263	248
106.0	31.23	3.06	468	468	468	468	461	440	419	398	377	356	337	318	300	283	267
113.0	33.25	3.07	499	499	499	499	492	469	447	424	402	380	359	339	320	302	285
119.5	35.16	3.09	527	527	527	527	521	498	474	450	427	404	382	361	341	321	303
126.5	37.21	3.10	558	558	558	558	552	528	502	477	453	429	405	383	362	341	322
133.5	39.26	3.11	589	589	589	589	583	557	531	505	479	453	429	405	383	361	341
140.5	41.32	3.13	620	620	620	620	615	588	561	533	506	479	453	428	405	382	361
147.5	43.40	3.14	651	651	651	651	647	619	590	561	532	504	477	451	427	403	381
154.5	45.48	3.15	682	682	682	682	679	649	619	589	559	530	502	474	448	423	400
162.0	47.57	3.17	714	714	714	714	711	681	649	618	587	557	527	499	472	446	421
169.0	49.68	3.18	745	745	745	745	744	712	679	647	614	583	552	522	494	467	442
176.0	51.79	3.19	777	777	777	777	776	743	709	675	642	609	577	546	516	488	462
183.0	53.78	3.20	807	807	807	807	807	773	738	702	668	633	600	568	538	509	481
190.0	55.91	3.22	839	839	839	839	839	805	769	733	697	661	627	594	562	532	503

Loads to right of heavy vertical lines for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 12" ROLLED COLUMNS BETHLEHEM SECTIONS

Weight per Foot	DIMENSIONS d	b	t	h	m	n	f	c	g	u	Rivet	AXIS X-X I	S	r	AXIS Y-Y I	S	r
							12" BETHLEHEM Bs										
28.0	12.00	6.500	.245	10.900	.550	.290	.35	10.250	3	7/16	3/4	213.6	35.60	5.08	16.4	5.04	1.41
36.0	12.25	6.555	.300	10.900	.675	.415	.35	10.250	3	9/16	3/4	281.8	46.01	5.16	22.7	6.93	1.46
40.0	12.00	6.750	.330	10.530	.735	.468	.40	9.750	3	23/32	3/4	301.2	50.20	5.05	27.6	8.18	1.53
48.5	12.25	6.815	.395	10.530	.860	.593	.40	9.750	3	27/32	3/4	373.2	60.93	5.11	35.1	10.29	1.57
							12" BETHLEHEM Gs										
55.5	12.00	10.000	.380	10.388	.806	.405	.45	9.500	5½	5/8	1"	435.6	72.60	5.16	84.9	17.0	2.28
61.0	12.12	10.030	.410	10.388	.866	.465	.45	9.500	5½	11/16	1"	483.6	79.80	5.20	95.9	19.1	2.31
70.5	12.00	10.250	.470	10.066	.967	.560	.55	9.000	5½	25/32	1"	543.6	90.60	5.11	119.7	23.4	2.40
76.5	12.12	10.290	.510	10.066	1.027	.620	.55	9.000	5½	13/16	1"	594.2	98.05	5.14	132.1	25.7	2.42
							12" BETHLEHEM H COLUMNS										
40.5	11.500	8.00	.31	10.384	.558	.481		9.188	5½	1/2	1"	287.7	50.0	4.93	42.8	10.7	1.90
45.5	11.625	8.04	.35	10.384	.620	.543		9.188	5½	9/16	1"	326.4	56.1	4.95	48.9	12.2	1.92
50.5	11.750	8.08	.39	10.384	.683	.606		9.188	5½	5/8	1"	366.1	62.3	4.98	55.1	13.6	1.93
55.0	11.875	8.12	.43	10.384	.745	.668		9.188	5½	11/16	1"	406.9	68.5	5.00	61.5	15.2	1.94
52.5	11.625	10.00	.35	10.384	.620	.524		9.188	5½	9/16	1"	390.7	67.2	5.04	91.5	18.3	2.44
58.0	11.750	10.04	.39	10.384	.683	.586		9.188	5½	5/8	1"	438.8	74.7	5.06	103.2	20.6	2.45
64.0	11.875	10.08	.43	10.384	.745	.649		9.188	5½	11/16	1"	488.2	82.2	5.09	115.1	22.8	2.47
70.0	12.000	10.12	.47	10.384	.808	.711		9.188	5½	3/4	1"	538.8	89.8	5.12	127.3	25.2	2.49
65.5	11.750	11.92	.39	10.384	.683	.567		9.188	9"	5/8	1"	506.6	86.2	5.12	168.6	28.3	2.96
72.5	11.875	11.96	.43	10.384	.745	.630		9.188	9"	11/16	1"	564.1	95.0	5.15	188.2	31.5	2.98
79.0	12.000	12.00	.47	10.384	.808	.692		9.188	9"	3/4	1"	623.1	103.9	5.18	208.2	34.7	2.99
85.5	12.125	12.04	.51	10.384	.870	.755		9.188	9"	13/16	1"	683.6	112.8	5.21	228.5	38.0	3.01
92.5	12.250	12.08	.55	10.384	.933	.817		9.188	9"	7/8	1"	745.7	121.7	5.23	249.2	41.3	3.03
99.5	12.375	12.12	.59	10.384	.995	.880		9.188	9"	15/16	1"	809.2	130.8	5.26	270.3	44.6	3.04
106.0	12.500	12.16	.63	10.384	1.058	.942		9.188	9"	1"	1"	874.3	139.9	5.29	291.8	48.0	3.06
113.0	12.625	12.20	.67	10.384	1.120	1.005		9.188	9"	1 1/16	1"	941.0	149.1	5.32	313.7	51.4	3.07
119.5	12.750	12.23	.70	10.384	1.183	1.067		9.188	9"	1 1/8	1"	1007.5	158.0	5.35	335.1	54.8	3.09
126.5	12.875	12.27	.74	10.384	1.245	1.130		9.188	9"	1 3/16	1"	1077.4	167.4	5.38	357.7	58.3	3.10
133.5	13.000	12.31	.78	10.384	1.308	1.192		9.188	9"	1 1/4	1"	1148.9	176.8	5.41	380.8	61.9	3.11
140.5	13.125	12.35	.82	10.384	1.370	1.255		9.188	9"	1 5/16	1"	1222.1	186.2	5.44	404.2	65.5	3.13
147.5	13.250	12.39	.86	10.384	1.433	1.317		9.188	9"	1 3/8	1"	1296.9	195.8	5.47	428.1	69.1	3.14
154.5	13.375	12.43	.90	10.384	1.495	1.380		9.188	9"	1 7/16	1"	1373.5	205.4	5.50	452.3	72.8	3.15
162.0	13.500	12.47	.94	10.384	1.558	1.442		9.188	9"	1 1/2	1"	1451.9	215.1	5.52	477.0	76.5	3.17
169.0	13.625	12.51	.98	10.384	1.620	1.505		9.188	9"	1 9/16	1"	1532.0	224.9	5.55	502.2	80.3	3.18
176.0	13.750	12.55	1.02	10.384	1.683	1.567		9.188	9"	1 5/8	1"	1613.9	234.7	5.58	527.7	84.1	3.19
183.0	13.875	12.58	1.05	10.384	1.745	1.630		9.188	9"	1 11/16	1"	1695.4	244.4	5.61	552.4	87.8	3.20
190.0	14.000	12.62	1.09	10.384	1.808	1.692		9.188	9"	1 3/4	1"	1780.9	254.4	5.64	578.7	91.7	3.22



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

12"

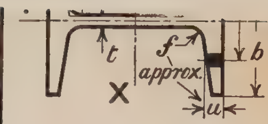
ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 14″ ROLLED COLUMNS BETHLEHEM SECTIONS

Weight Per Foot	Area Square Inches	Least Radius Gyration	Unsupported Length in Feet: 9	10	12	14	16	18	20	22	24	26	28	30	32	36	40	44	48
14″ BETHLEHEM H COLUMNS 8—10 and 12″ Nominal Flange Widths																			
43.0	12.58	1.86	189	184	170	156	142	129	118	107	97	88	81						
48.0	14.12	1.88	212	207	192	176	161	147	133	121	110	101	92						
53.5	15.67	1.89	235	231	213	196	179	163	149	135	123	112	102						
58.5	17.23	1.90	258	254	235	216	198	181	164	150	136	124	113						
55.0	16.25	2.39	244	244	243	229	215	201	188	174	162	150	139						
61.5	18.04	2.41	271	271	271	256	240	224	209	195	181	168	156	145	135				
67.5	19.85	2.43	298	298	298	282	265	248	232	216	201	186	173	161	150				
73.5	21.66	2.44	325	325	325	309	290	272	254	236	220	204	190	177	164				
69.0	20.34	2.93	305	305	305	305	296	281	267	252	238	225	212	199	187	166	147		
76.0	22.39	2.95	336	336	336	336	326	311	295	279	264	249	234	221	208	184	163		
83.0	24.45	2.97	367	367	367	367	357	340	323	306	289	273	257	242	228	202	179		
90.0	26.52	2.98	398	398	398	398	388	369	351	333	314	297	280	264	248	220	195		
14″ BETHLEHEM H COLUMNS 14″ Nominal Flange Width																			
84.0	24.76	3.45	371	371	371	371	371	366	351	336	321	306	292	278	264	238	215	194	
92.0	27.05	3.47	406	406	406	406	406	401	385	368	352	336	320	305	290	262	236	213	
100.0	29.36	3.49	440	440	440	440	440	436	418	401	383	366	349	332	316	285	257	233	
107.5	31.67	3.50	475	475	475	475	475	471	452	433	414	396	377	359	342	309	279	252	
115.5	34.00	3.52	510	510	510	510	510	506	486	466	446	426	407	387	369	333	301	272	
123.5	36.33	3.54	545	545	545	545	545	542	521	500	478	457	436	415	395	358	323	292	
131.5	38.68	3.55	580	580	580	580	580	577	555	533	510	487	465	443	422	382	345	312	
139.0	40.88	3.57	613	613	613	613	613	612	588	565	540	517	493	470	448	406	367	332	
147.0	43.25	3.58	649	649	649	649	649	647	623	598	573	548	523	499	475	430	389	352	
155.0	45.62	3.60	684	684	684	684	684	684	659	632	606	579	553	528	503	456	413	374	
161.0	47.33	3.80	710	710	710	710	710	710	697	672	646	620	594	568	544	496	452	411	
168.0	49.51	3.82	743	743	743	743	743	743	731	705	677	650	623	597	571	521	475	432	
177.0	51.99	3.83	780	780	780	780	780	780	768	740	712	684	656	628	600	548	500	455	
185.0	54.48	3.84	817	817	817	817	817	817	806	777	747	718	688	659	630	576	525	478	
194.0	56.99	3.86	855	855	855	855	855	855	845	814	784	753	722	692	662	605	552	503	
202.0	59.50	3.87	893	893	893	893	893	893	882	851	819	787	755	724	692	632	577	527	
210.0	61.86	3.88	928	928	928	928	928	928	918	886	852	819	786	753	721	659	602	549	500
219.0	64.40	3.89	966	966	966	966	966	966	957	923	888	854	820	786	752	688	628	573	523
227.0	66.94	3.91	1004	1004	1004	1004	1004	1004	996	961	926	890	854	819	785	718	656	598	546
236.0	69.49	3.92	1042	1042	1042	1042	1042	1042	1035	999	962	925	888	852	816	747	682	623	569
245.0	72.05	3.93	1081	1081	1081	1081	1081	1081	1074	1038	999	960	922	885	847	776	709	648	592
254.0	74.62	3.94	1119	1119	1119	1119	1119	1119	1113	1075	1036	996	957	918	879	805	736	672	614
262.0	77.20	3.96	1158	1158	1158	1158	1158	1158	1154	1115	1075	1033	993	953	913	836	765	699	638
271.0	79.79	3.97	1197	1197	1197	1197	1197	1197	1194	1153	1111	1069	1028	986	945	866	792	724	662
280.0	82.39	3.98	1236	1236	1236	1236	1236	1236	1233	1191	1149	1106	1062	1020	978	896	821	750	685
289.0	85.01	3.99	1275	1275	1275	1275	1275	1275	1274	1231	1187	1142	1097	1053	1011	927	848	775	709
298.0	87.63	4.01	1314	1314	1314	1314	1314	1314	1314	1272	1226	1180	1135	1089	1045	959	878	804	735

Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 14" ROLLED CO

Weight per foot	DIMENSIONS											AXIS X-X					
	d	b	t	h	m	n	f	c	g	u	Riv.	I	S				
14" BETHLEHEM H COLUMNS 8—10 and 12" Nominal Flange Widths																	
43.0	13.375	8.00	.31	12.240	.567	.491	.60	11.063	5½	½	1"	408.2	61.0				
48.0	13.500	8.04	.35	12.240	.630	.553	.60	11.063	5½	9/16	1"	461.5	68.4				
53.5	13.625	8.08	.39	12.240	.692	.616	.60	11.063	5½	5/8	1"	516.2	75.8				
58.5	13.750	8.12	.43	12.240	.755	.678	.60	11.063	5½	11/16	1"	572.2	83.2	5.76	[illegible]	[illegible]	
55.0	13.500	10.00	.35	12.240	.630	.533	.60	11.063	5½	9/16	1"	551.0	81.6	5.82	93.1	18.6	2.39
61.5	13.625	10.04	.39	12.240	.692	.596	.60	11.063	5½	5/8	1"	616.9	90.6	5.85	104.8	20.9	2.41
67.5	13.750	10.08	.43	12.240	.755	.658	.60	11.063	5½	11/16	1"	684.3	99.5	5.87	116.8	23.2	2.43
73.5	13.875	10.12	.47	12.240	.817	.721	.60	11.063	5½	¾	1"	753.3	108.6	5.90	129.1	25.5	2.44
69.0	13.625	12.00	.39	12.240	.692	.576	.60	11.063	9"	5/8	1"	714.6	104.9	5.93	174.7	29.1	2.93
76.0	13.750	12.04	.43	12.240	.755	.639	.60	11.063	9"	11/16	1"	793.5	115.4	5.95	194.7	32.3	2.95
83.0	13.875	12.08	.47	12.240	.817	.701	.60	11.063	9"	¾	1"	874.2	126.0	5.98	215.1	35.6	2.97
90.0	14.000	12.12	.51	12.240	.880	.764	.60	11.063	9"	13/16	1"	956.7	136.7	6.01	235.8	38.9	2.98
14" BETHLEHEM H COLUMNS 14" Nominal Flange Width																	
84.0	13.750	13.92	.43	12.240	.755	.620	.60	11.063	10"	11/16	1"	895.5	130.2	6.01	294.5	42.3	3.45
92.0	13.875	13.96	.47	12.240	.817	.683	.60	11.063	10"	¾	1"	987.4	142.3	6.04	325.5	46.6	3.47
100.0	14.000	14.00	.51	12.240	.880	.745	.60	11.063	10"	13/16	1"	1081.2	154.5	6.07	356.9	51.0	3 49
107.5	14.125	14.04	.55	12.240	.942	.808	.60	11.063	10"	7/8	1"	1177.2	166.7	6.10	388.9	55.4	3.50
115.5	14.250	14.08	.59	12.240	1.005	.870	.60	11.063	10"	15/16	1"	1275.1	179.0	6.12	421.4	59.9	3.52
123.5	14.375	14.12	.63	12.240	1.067	.933	.60	11.063	10"	1"	1"	1375.1	191.3	6.15	454.4	64.4	3.54
131.5	14.500	14.16	.67	12.240	1.130	.995	.60	11.063	10"	1 1/16	1"	1477.3	203.8	6.18	488.0	68.9	3.55
139.0	14.625	14.19	.70	12.240	1.192	1.058	.60	11.063	10"	1 1/8	1"	1578.9	215.9	6.21	520 9	73.4	3.57
147.0	14.750	14.23	.74	12.240	1.255	1.120	.60	11.063	10"	1 3/16	1"	1685.3	228.5	6.24	555.5	78.1	3.58
155.0	14.875	14.27	.78	12.240	1.317	1.183	.60	11.063	10"	1 ¼	1"	1793.8	241.2	6.27	590.6	82.8	3.60
161.0	14.875	15.00	.78	12.240	1.317	1.175	.60	11.063	10"	1 ¼	1"	1874.4	252.0	6.29	682.5	91.0	3.80
168.0	15.000	15.02	.80	12.240	1.380	1.237	.60	11.063	10"	1 5/16	1"	1984.6	264.6	6.33	720.6	96.0	3.82
177.0	15.125	15.06	.84	12.240	1.442	1.300	.60	11.063	10"	1 3/8	1"	2102.6	278.0	6.36	762.1	101.2	3.83
185.0	15.250	15.10	.88	12.240	1.505	1.362	.60	11.063	10"	1 7/16	1"	2223.0	291.5	6.39	804.2	106.5	3.84
194.0	15.375	15.14	.92	12.240	1.567	1.425	.60	11.063	10"	1 ½	1"	2345.8	305.1	6.42	846.9	111.9	3.86
202.0	15.500	15.18	.96	12.240	1.630	1.487	.60	11.063	10"	1 9/16	1"	2470.9	318.8	6.44	890.3	117.3	3.87
210.0	15.625	15.21	.99	12.240	1.692	1.550	.60	11.063	10"	1 5/8	1"	2595.4	332.2	6.48	932.4	122.6	3.88
219.0	15.750	15.25	1.03	12.240	1.755	1.612	.60	11.063	10"	1 11/16	1"	2725.3	346.1	6.51	976.9	128.1	3.89
227.0	15.875	15.29	1.07	12.240	1.817	1.675	.60	11.063	10"	1 ¾	1"	2857.8	360.0	6.53	1022.0	133.7	3.91
236.0	16.000	15.33	1.11	12.240	1.880	1.737	.60	11.063	10"	1 13/16	1"	2992.9	374.1	6.56	1067.8	139.3	3.92
245.0	16.125	15.37	1.15	12.240	1.942	1.800	.60	11.063	10"	1 7/8	1"	3130.4	388.3	6.59	1114.2	145.0	3.93
254.0	16.250	15.41	1.19	12.240	2.005	1.862	.60	11.063	10"	1 15/16	1"	3270.6	402.5	6.62	1161.2	150.7	3.94
262.0	16.375	15.45	1.23	12.240	2.067	1.925	.60	11.063	10"	2"	1"	3413.4	416.9	6.65	1209.0	156.5	3.96
271.0	16.500	15.49	1.27	12.240	2.130	1.987	.60	11.063	10"	2 1/16	1"	3558.8	431.4	6.68	1257.3	162.3	3.97
280.0	16.625	15.53	1.31	12.240	2.192	2.050	.60	11.063	10"	2 1/8	1"	3706.9	445.9	6.71	1306.4	168.2	3.98
289.0	16.750	15.57	1.35	12.240	2.255	2.112	.60	11.063	10"	2 3/16	1"	3857.7	460.6	6.74	1356.1	174.2	3.99
298.0	16.875	15.61	1.39	12.240	2.317	2.175	.60	11.063	10"	2 ¼	1"	4011.3	475.4	6.77	1406.5	180.2	4.01



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

14"

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 14″ BETHLEHEM H COLUMNS WITH COVER PLATES

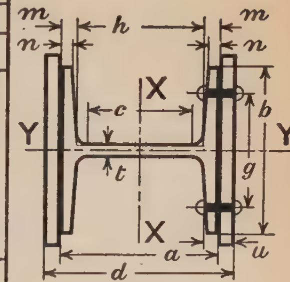
2 Cover Plates	Weight per foot	Area Square Inches	Least Radius Gyration	Unsupported Length in Feet: 20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
14″ × 262# BETHLEHEM H COLUMN																		
17 × 3/8	305	89.95	4.11	1349	1317	1272	1227	1181	1135	1090	1046	1003	962	921	882	845	809	774
7/16	313	92.08	4.13	1381	1351	1305	1258	1212	1165	1120	1075	1030	988	947	907	868	831	797
1/2	320	94.20	4.14	1413	1383	1336	1289	1242	1194	1147	1102	1057	1013	971	930	891	853	817
9/16	327	96.33	4.16	1445	1417	1370	1321	1273	1224	1177	1130	1085	1039	997	955	915	877	840
5/8	334	98.45	4.18	1477	1450	1403	1353	1304	1255	1207	1159	1112	1067	1023	981	939	900	862
17 × 11/16	342	100.58	4.20	1509	1485	1435	1386	1336	1285	1236	1188	1141	1094	1049	1006	964	924	885
3/4	349	102.70	4.21	1541	1517	1468	1416	1365	1315	1264	1215	1167	1119	1073	1029	986	946	906
13/16	356	104.83	4.23	1572	1551	1500	1449	1397	1346	1295	1244	1195	1147	1101	1055	1012	970	930
7/8	363	106.95	4.24	1604	1584	1533	1480	1427	1374	1323	1272	1221	1172	1125	1078	1034	991	951
15/16	370	109.08	4.26	1636	1619	1565	1512	1458	1405	1353	1301	1249	1200	1151	1104	1058	1016	974
14″ × 298# BETHLEHEM H COLUMN																		
18 × 5/8	375	110.13	4.28	1652	1637	1584	1531	1477	1423	1369	1317	1265	1216	1166	1119	1073	1031	988
11/16	382	112.38	4.30	1686	1672	1619	1565	1510	1456	1401	1349	1296	1245	1196	1147	1100	1056	1013
3/4	390	114.63	4.32	1719	1709	1655	1600	1544	1490	1434	1380	1326	1275	1224	1175	1127	1082	1039
13/16	397	116.88	4.33	1753	1744	1689	1633	1577	1521	1465	1408	1355	1302	1251	1200	1151	1106	1061
18 × 7/8	405	119.13	4.35	1787	1780	1725	1668	1611	1553	1496	1440	1385	1332	1279	1228	1178	1132	1086
15/16	413	121.38	4.37	1821	1816	1760	1702	1645	1586	1528	1472	1415	1362	1308	1256	1205	1158	1112
1	420	123.63	4.39	1854	1853	1796	1737	1679	1620	1561	1503	1446	1391	1338	1285	1234	1184	1137
1 1/16	428	125.88	4.40	1888	1888	1830	1771	1712	1652	1592	1533	1475	1419	1365	1310	1259	1208	1161
1 1/8	436	128.13	4.42	1922	1922	1866	1807	1746	1685	1625	1566	1507	1449	1394	1339	1286	1235	1186
19 × 1 1/8	443	130.38	4.54	1956	1956	1918	1859	1799	1739	1679	1619	1562	1503	1447	1392	1340	1288	1239
1 3/16	451	132.75	4.56	1991	1991	1955	1896	1836	1775	1714	1654	1594	1536	1479	1423	1369	1317	1266
1 1/4	460	135.13	4.58	2027	2027	1995	1934	1873	1811	1749	1688	1627	1569	1511	1454	1399	1346	1295
1 5/16	468	137.50	4.60	2063	2063	2032	1972	1910	1847	1785	1722	1661	1601	1543	1485	1429	1375	1323
1 3/8	476	139.88	4.61	2098	2098	2069	2007	1944	1881	1817	1754	1693	1631	1571	1514	1456	1402	1348
19 × 1 7/16	484	142.25	4.63	2134	2134	2108	2044	1982	1916	1852	1790	1725	1664	1603	1543	1487	1431	1377
1 1/2	492	144.63	4.65	2169	2169	2146	2083	2018	1953	1887	1824	1760	1697	1636	1575	1517	1461	1406
1 9/16	500	147.00	4.66	2205	2205	2183	2118	2052	1986	1921	1856	1790	1727	1664	1604	1545	1486	1432
1 5/8	508	149.38	4.67	2241	2241	2220	2154	2088	2021	1955	1888	1822	1758	1694	1633	1573	1513	1458
1 11/16	516	151.75	4.69	2276	2276	2258	2193	2126	2058	1991	1923	1856	1791	1727	1665	1602	1543	1486
19 × 1 3/4	524	154.13	4.70	2312	2312	2295	2229	2161	2093	2024	1956	1888	1822	1757	1692	1631	1571	1512
1 13/16	532	156.50	4.71	2348	2348	2332	2265	2196	2127	2058	1988	1920	1853	1786	1722	1659	1598	1538
1 7/8	540	158.88	4.73	2383	2383	2372	2304	2234	2164	2094	2024	1954	1886	1819	1754	1690	1629	1568
1 15/16	548	161.25	4.74	2419	2419	2409	2340	2269	2198	2127	2056	1987	1917	1850	1782	1719	1654	1595
2	556	163.63	4.75	2454	2454	2446	2376	2306	2234	2162	2090	2019	1949	1880	1811	1748	1682	1622

Loads to right of heavy vertical lines are for Secondary Members ONLY. For 14″ Bethlehem 149# Special H Column with cover plates see following pages.

DIMENSIONS AND FUNCTIONS OF 14″ BETHLEHEM H COLUMNS WITH COVER PLATES

2 Cover Plates	Weight per foot	DIMENSIONS d	b	t	a	h	m	n	c	g	u	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
14″ × 262# BETHLEHEM H COLUMN																		
17 × 3/8	305	17⅛	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 3/8	1″	4307.8	503.1	6.92	1516.0	178.4	4.11
7/16	313	17¼	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 7/16	1″	4464.8	517.7	6.96	1567.2	184.4	4.13
1/2	320	17⅜	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 1/2	1″	4624.0	532.3	7.01	1618.4	190.4	4.14
9/16	327	17½	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 9/16	1″	4785.5	546.9	7.05	1669.6	196.4	4.16
5/8	334	17⅝	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 5/8	1″	4949.4	561.6	7.09	1720.7	202.4	4.18
17 × 11/16	342	17¾	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 11/16	1″	5115.6	576.4	7.13	1771.9	208.5	4.20
3/4	349	17⅞	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 3/4	1″	5284.1	591.2	7.17	1823.1	214.5	4.21
13/16	356	18″	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 13/16	1″	5455.1	606.1	7.21	1874.3	220.5	4.23
7/8	363	18⅛	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 7/8	1″	5628.4	621.1	7.25	1925.4	226.5	4.24
15/16	370	18¼	15.45	1.23	16⅜	12.24	2.067	1.925	1 11/16	10″	2 15/16	1″	5804.1	636.1	7.29	1976.6	232.5	4.26
14″ × 298# BETHLEHEM H COLUMN																		
18 × 5/8	375	18⅛	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	2 7/8	1″	5734.7	632.8	7.22	2014.0	223.8	4.28
11/16	382	18¼	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	2 15/16	1″	5920.7	648.8	7.26	2074.7	230.5	4.30
3/4	390	18⅜	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3″	1″	6109.4	665.0	7.30	2135.5	237.3	4.32
13/16	397	18½	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 1/16	1″	6300.6	681.1	7.34	2196.2	244.0	4.33
18 × 7/8	405	18⅝	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 1/8	1″	6494.4	697.4	7.38	2257.0	250.8	4.35
15/16	413	18¾	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 3/16	1″	6690.8	713.7	7.42	2317.7	257.5	4.37
1	420	18⅞	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 1/4	1″	6889.9	730.1	7.47	2378.5	264.3	4.39
1 1/16	428	19″	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 5/16	1″	7091.6	746.5	7.51	2439.2	271.0	4.40
1 1/8	436	19⅛	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 3/8	1″	7296.0	763.0	7.55	2500.0	277.8	4.42
19 × 1 1/8	443	19⅛	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 3/8	1″	7478.5	782.1	7.57	2692.5	283.4	4.54
1 3/16	451	19¼	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 7/16	1″	7697.1	799.7	7.61	2764.0	290.9	4.56
1 1/4	460	19⅜	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 1/2	1″	7918.6	817.4	7.66	2835.4	298.5	4.58
1 5/16	468	19½	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 9/16	1″	8142.9	835.2	7.70	2906.9	306.0	4.60
1 3/8	476	19⅝	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 5/8	1″	8370.1	853.0	7.74	2978.3	313.5	4.61
19 × 1 7/16	484	19¾	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 11/16	1″	8600.3	870.9	7.78	3049.8	321.0	4.63
1 1/2	492	19⅞	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 3/4	1″	8833.3	888.9	7.82	3121.2	328.5	4.65
1 9/16	500	20″	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 13/16	1″	9069.4	906.9	7.85	3192.7	336.1	4.66
1 5/8	508	20⅛	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 7/8	1″	9308.3	925.1	7.89	3264.1	343.6	4.67
1 11/16	516	20¼	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	3 15/16	1″	9550.3	943.2	7.93	3335.6	351.1	4.69
19 × 1 3/4	524	20⅜	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	4″	1″	9795.3	961.5	7.97	3407.0	358.6	4.70
1 13/16	532	20½	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	4 1/16	1″	10043.3	979.8	8.01	3478.5	366.2	4.71
1 7/8	540	20⅝	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	4 1/8	1″	10294.4	998.2	8.05	3549.9	373.7	4.73
1 15/16	548	20¾	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	4 3/16	1″	10548.5	1016.7	8.09	3621.4	381.2	4.74
2	556	20⅞	15.61	1.39	16⅞	12.24	2.317	2.175	1 11/16	10″	4 1/4	1″	10805.7	1035.3	8.13	3692.8	388.7	4.75

For 14″ Bethlehem 149# Special H Column with cover plates see following pages.



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

14″

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 14″ BETHLEHEM SPECIAL H COLUMN WITH COVER PLATES

2 Cover Plates	Weight per foot	Area Square Inches	Least Radius Gyration	Unsupported Length in Feet: 18	20	22	24	26	28	30	32	34	36	38	40	42	44	48
14″ × 149# BETHLEHEM SPECIAL H COLUMN																		
None	149.	43.82	3.27															
17 × 1 1/4	293.5	86.32	4.16	1295	1295	1270	1227	1183	1140	1097	1055	1013	972	931	893	855	820	753
1 5/16	300.7	88.44	4.18	1327	1327	1303	1260	1215	1172	1128	1084	1041	999	959	919	881	844	775
1 3/8	307.9	90.57	4.20	1359	1359	1337	1292	1248	1203	1157	1113	1070	1027	985	945	906	868	797
1 7/16	315.2	92.69	4.21	1390	1390	1369	1325	1278	1232	1186	1141	1097	1053	1010	969	929	890	818
1 1/2	322.4	94.82	4.23	1422	1422	1403	1357	1310	1264	1217	1171	1126	1081	1037	996	954	925	841
17 × 1 9/16	329.6	96.94	4.25	1454	1454	1437	1390	1343	1295	1248	1200	1155	1109	1064	1021	979	938	864
1 5/8	336.8	99.07	4.26	1486	1486	1470	1422	1373	1325	1276	1228	1182	1134	1090	1045	1003	961	885
1 11/16	344.1	101.19	4.28	1518	1518	1504	1455	1407	1357	1307	1258	1210	1163	1117	1072	1028	986	908
1 3/4	351.3	103.32	4.29	1550	1550	1536	1487	1437	1387	1337	1286	1238	1189	1143	1097	1053	1009	929
1 13/16	358.5	105.44	4.30	1582	1582	1569	1519	1469	1417	1367	1315	1265	1216	1168	1122	1077	1032	950
18 × 1 3/4	363.2	106.82	4.51	1602	1602	1602	1567	1519	1469	1420	1371	1321	1273	1226	1180	1135	1092	1008
1 13/16	370.8	109.07	4.52	1636	1636	1636	1602	1552	1502	1452	1402	1351	1302	1254	1207	1162	1117	1032
1 7/8	378.5	111.32	4.54	1670	1670	1670	1638	1587	1536	1485	1434	1383	1334	1284	1236	1189	1144	1058
1 15/16	386.1	113.57	4.55	1704	1704	1704	1672	1621	1568	1516	1464	1413	1362	1312	1263	1215	1169	1081
2″	393.8	115.82	4.56	1737	1737	1737	1706	1654	1602	1549	1495	1443	1391	1340	1290	1242	1194	1105
18 × 2 1/16	401.4	118.07	4.58	1771	1771	1771	1743	1690	1636	1582	1528	1475	1422	1371	1320	1270	1222	1131
2 1/8	409.1	120.32	4.59	1805	1805	1805	1777	1723	1669	1613	1559	1505	1451	1399	1348	1297	1248	1155
2 3/16	416.7	122.57	4.60	1839	1839	1839	1812	1758	1702	1646	1591	1535	1481	1427	1375	1324	1274	1179
2 1/4	424.4	124.82	4.61	1872	1872	1872	1846	1791	1735	1679	1621	1565	1510	1455	1402	1351	1299	1203
2 5/16	432.0	127.07	4.62	1906	1906	1906	1882	1825	1768	1710	1665	1596	1539	1484	1430	1376	1325	1227
19 × 2 1/4	439.7	129.32	4.85	1940	1940	1940	1940	1893	1838	1782	1726	1671	1615	1561	1508	1455	1403	1305
2 5/16	447.8	131.69	4.86	1975	1975	1975	1975	1929	1873	1817	1759	1704	1647	1592	1538	1484	1431	1331
2 3/8	455.8	134.07	4.87	2011	2011	2011	2011	1965	1909	1852	1794	1736	1679	1622	1567	1514	1460	1358
2 7/16	463.9	136.44	4.88	2047	2047	2047	2047	2002	1944	1886	1827	1770	1711	1654	1598	1542	1489	1384
2 1/2	472.0	138.82	4.89	2082	2082	2082	2082	2038	1980	1920	1862	1802	1744	1685	1627	1571	1516	1410
19 × 2 9/16	480.1	141.19	4.91	2118	2118	2118	2118	2075	2016	1957	1898	1837	1778	1718	1659	1604	1547	1440
2 5/8	488.1	143.57	4.92	2154	2154	2154	2154	2112	2053	1991	1931	1869	1809	1749	1690	1632	1576	1467
2 11/16	496.2	145.94	4.93	2189	2189	2189	2189	2148	2088	2027	1966	1903	1842	1780	1721	1662	1604	1494
2 3/4	504.3	148.32	4.94	2225	2225	2225	2225	2185	2124	2062	1999	1937	1873	1812	1752	1691	1633	1520
2 13/16	512.4	150.69	4.94	2260	2260	2260	2260	2220	2158	2095	2031	1968	1903	1841	1780	1718	1659	1545
2 7/8	520.4	153.07	4.95	2296	2296	2296	2296	2256	2193	2129	2065	2001	1936	1872	1809	1748	1688	1572

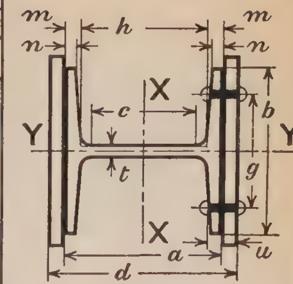
Loads to right of heavy vertical lines are for Secondary Members ONLY.

For 14″ Bethlehem 262# and 298# H Columns with cover plates see preceding pages.

DIMENSIONS AND FUNCTIONS OF 14″ BETHLEHEM SPECIAL H COLUMN WITH COVER PLATES

2 Cover Plates	Weight per foot	DIMENSIONS d	b	t	a	h	m	n	c	g	u	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
14″ × 149# BETHLEHEM SPECIAL H COLUMN																		
None	149.0	14 1/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	7/8	7/8	1379.1	195.3	5.61	468.8	62.9	3.27
17 × 1 1/4	293.5	16 5/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 1/8	7/8	3896.3	468.7	6.72	1492.4	175.6	4.16
1 5/16	300.7	16 3/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 3/16	7/8	4044.2	482.9	6.76	1543.5	181.6	4.18
1 3/8	307.9	16 7/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 1/4	7/8	4194.4	497.1	6.81	1594.7	187.6	4.20
1 7/16	315.2	17″	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 5/16	7/8	4346.8	511.4	6.85	1645.9	193.6	4.21
1 1/2	322.4	17 1/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 3/8	7/8	4501.5	525.7	6.89	1697.1	199.7	4.23
17 × 1 9/16	329.6	17 1/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 7/16	7/8	4658.4	540.1	6.93	1748.3	205.7	4.25
1 5/8	336.8	17 3/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 1/2	7/8	4817.6	554.5	6.97	1799.4	211.7	4.26
1 11/16	344.1	17 1/2	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 9/16	7/8	4979.2	569.0	7.01	1850.6	217.7	4.28
1 3/4	351.3	17 5/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 5/8	7/8	5143.0	583.6	7.06	1901.8	223.7	4.29
1 13/16	358.5	17 3/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 11/16	7/8	5309.2	598.2	7.10	1953.0	229.8	4.30
18 × 1 3/4	363.2	17 5/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 5/8	7/8	5364.4	608.7	7.09	2169.8	241.1	4.51
1 13/16	370.8	17 3/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 11/16	7/8	5540.4	624.3	7.13	2230.6	247.8	4.52
1 7/8	378.5	17 7/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 3/4	7/8	5718.9	639.9	7.17	2291.3	254.6	4.54
1 15/16	386.1	18″	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 13/16	7/8	5899.9	655.5	7.21	2352.1	261.3	4.55
2″	393.8	18 1/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 7/8	7/8	6083.4	671.3	7.25	2412.8	268.1	4.56
18 × 2 1/16	401.4	18 1/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	2 15/16	7/8	6269.5	687.1	7.29	2473.6	274.8	4.58
2 1/8	409.1	18 3/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3″	7/8	6458.1	702.9	7.33	2534.3	281.6	4.59
2 3/16	416.7	18 1/2	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 1/16	7/8	6649.3	718.8	7.37	2595.1	288.3	4.60
2 1/4	424.4	18 5/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 1/8	7/8	6843.1	734.8	7.40	2655.8	295.1	4.61
2 5/16	432.0	18 3/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 3/16	7/8	7039.6	750.9	7.44	2716.6	301.8	4.62
19 × 2 1/4	439.7	18 5/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 1/8	7/8	7146.7	767.4	7.43	3040.9	320.1	4.85
2 5/16	447.8	18 3/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 3/16	7/8	7354.1	784.4	7.47	3112.4	327.6	4.86
2 3/8	455.8	18 7/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 1/4	7/8	7564.2	801.5	7.51	3183.8	335.1	4.87
2 7/16	463.9	19″	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 5/16	7/8	7777.1	818.6	7.55	3255.3	342.7	4.88
2 1/2	472.0	19 1/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 3/8	7/8	7992.9	835.9	7.59	3326.7	350.2	4.89
19 × 2 9/16	480.1	19 1/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 7/16	7/8	8211.5	853.1	7.63	3398.2	357.7	4.91
2 5/8	488.1	19 3/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 1/2	7/8	8432.9	870.5	7.66	3469.6	365.2	4.92
2 11/16	496.2	19 1/2	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 9/16	7/8	8657.3	887.9	7.70	3541.1	372.7	4.93
2 3/4	504.3	19 5/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 5/8	7/8	8884.5	905.4	7.74	3612.5	380.3	4.94
2 13/16	512.4	19 3/4	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 11/16	7/8	9114.6	923.0	7.78	3684.0	387.8	4.94
2 7/8	520.4	19 7/8	14.90	1.41	14 1/8	12.24	.942	.808	11 1/16	10″	3 3/4	7/8	9347.7	940.6	7.81	3755.4	395.3	4.95

For 14″ Bethlehem 262# and 298# H Columns with cover plates see preceding pages.



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

14″

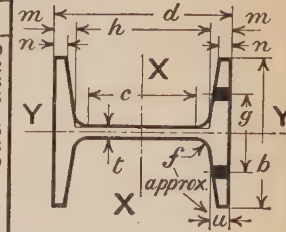
ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 16" ROLLED COLUMNS BETHLEHEM SECTIONS

Weight per foot	Area Square Inch	Least Radius Gyration	UNSUPPORTED LENGTH IN FEET 16	18	20	22	24	26	28	30	32	34	36	38	40	44	48
16" BETHLEHEM H COLUMNS																	
143.0	42.03	3.90	630	630	625	603	580	558	536	514	492	470	450	430	411	375	342
151.0	44.56	3.92	668	668	664	641	617	593	569	546	523	501	479	458	438	400	365
160.0	47.10	3.93	707	707	702	678	653	628	603	578	554	530	507	485	463	423	387
169.0	49.65	3.95	745	745	742	716	690	664	638	612	586	561	537	513	491	448	410
177.0	52.20	3.96	783	783	780	754	727	698	671	644	617	591	565	541	517	472	432
186.0	54.77	3.98	822	822	820	792	763	735	706	678	650	622	596	570	546	498	456
195.0	57.35	4.00	860	860	860	832	801	771	742	712	683	654	626	599	574	524	479
203.0	59.94	4.01	899	899	899	870	839	807	776	745	715	685	656	628	601	550	503
212.0	62.53	4.02	938	938	938	909	875	844	811	778	747	716	685	657	628	575	526
221.0	65.14	4.04	977	977	977	948	914	881	847	814	780	748	717	687	657	602	550
230.0	67.60	4.05	1014	1014	1014	984	950	915	880	846	811	778	746	714	683	626	573
238.0	70.07	4.07	1051	1051	1051	1022	987	951	914	879	844	809	776	743	711	652	597
247.0	72.70	4.08	1091	1091	1091	1061	1025	988	950	913	877	841	806	773	739	678	621
256.0	75.35	4.10	1130	1130	1130	1102	1065	1026	988	949	912	875	839	804	770	706	647
265.0	78.00	4.11	1170	1170	1170	1142	1103	1064	1024	984	945	907	870	834	799	732	672
274.0	80.67	4.12	1210	1210	1210	1183	1142	1101	1060	1020	979	940	901	864	828	759	696
288.0	84.69	4.14	1270	1270	1270	1243	1201	1159	1116	1073	1032	991	950	910	873	801	734
301.0	88.56	4.16	1328	1328	1328	1303	1259	1214	1170	1126	1082	1039	997	956	917	841	772
314.0	92.45	4.18	1387	1387	1387	1362	1317	1270	1225	1179	1133	1088	1045	1002	961	882	810
328.0	96.53	4.20	1448	1448	1448	1425	1377	1330	1282	1234	1186	1140	1095	1050	1007	925	849
342.0	100.63	4.22	1509	1509	1509	1487	1439	1390	1339	1290	1241	1192	1145	1099	1055	969	891
356.0	104.75	4.24	1571	1571	1571	1551	1501	1450	1397	1346	1296	1245	1196	1148	1102	1013	931
370.0	108.90	4.26	1634	1634	1634	1616	1563	1509	1456	1403	1350	1299	1247	1198	1149	1056	972
384.0	113.07	4.27	1696	1696	1696	1679	1625	1569	1514	1459	1404	1350	1297	1246	1195	1099	1012
399.0	117.26	4.29	1759	1759	1759	1744	1687	1631	1574	1517	1460	1405	1350	1297	1245	1146	1054
413.0	121.48	4.31	1822	1822	1822	1810	1753	1695	1635	1577	1517	1460	1403	1348	1295	1192	1097
427.0	125.72	4.33	1886	1886	1886	1876	1817	1756	1696	1636	1575	1515	1457	1401	1345	1238	1142

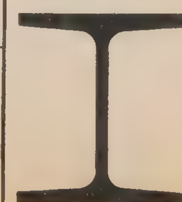
Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 16″ ROLLED COLUMNS BETHLEHEM SECTIONS

Weight per foot	DIMENSIONS										AXIS X-X			AXIS Y-Y		
	d	b	t	h	m	n	f	c	g	u	Riv.	I	S	r	I	S	r
16″ BETHLEHEM H COLUMNS																	
143.0	14.500	15.54	.72	12.240	1.130	.982	.60	11.063	10″	1 1/16	1″	1610.4	222.1	6.19	638.9	82.2	3.90
151.0	14.625	15.58	.76	12.240	1.193	1.044	.60	11.063	10″	1 1/8	1″	1723.8	235.7	6.22	683.4	87.7	3.92
160.0	14.750	15.62	.80	12.240	1.255	1.107	.60	11.063	10″	1 3/16	1″	1839.5	249.4	6.25	728.5	93.3	3.93
169.0	14.875	15.66	.84	12.240	1.318	1.169	.60	11.063	10″	1 1/4	1″	1957.6	263.2	6.28	774.2	98.9	3.95
177.0	15.000	15.70	.88	12.240	1.380	1.232	.60	11.063	10″	1 5/16	1″	2078.0	277.1	6.31	820.7	104.5	3.96
186.0	15.125	15.74	.92	12.240	1.443	1.294	.60	11.063	10″	1 3/8	1″	2200.9	291.0	6.34	867.7	110.3	3.98
195.0	15.250	15.78	.96	12.240	1.505	1.357	.60	11.063	10″	1 7/16	1″	2326.1	305.1	6.37	915.5	116.0	4.00
203.0	15.375	15.82	1.00	12.240	1.568	1.419	.60	11.063	10″	1 1/2	1″	2453.9	319.2	6.40	963.9	121.9	4.01
212.0	15.500	15.86	1.04	12.240	1.630	1.482	.60	11.063	10″	1 9/16	1″	2584.1	333.4	6.43	1013.0	127.7	4.02
221.0	15.625	15.90	1.08	12.240	1.693	1.544	.60	11.063	10″	1 5/8	1″	2716.9	347.8	6.46	1062.7	133.7	4.04
230.0	15.750	15.93	1.11	12.240	1.755	1.607	.60	11.063	10″	1 11/16	1″	2848.9	361.8	6.49	1111.0	139.5	4.05
238.0	15.875	15.96	1.14	12.240	1.818	1.669	.60	11.063	10″	1 3/4	1″	2983.4	375.9	6.53	1159.8	145.3	4.07
247.0	16.000	16.00	1.18	12.240	1.880	1.732	.60	11.063	10″	1 13/16	1″	3123.7	390.5	6.55	1211.4	151.4	4.08
256.0	16.125	16.04	1.22	12.240	1.943	1.794	.60	11.063	10″	1 7/8	1″	3266.7	405.2	6.58	1263.8	157.6	4.10
265.0	16.250	16.08	1.26	12.240	2.005	1.857	.60	11.063	10″	1 15/16	1″	3412.4	420.0	6.61	1316.8	163.8	4.11
274.0	16.375	16.12	1.30	12.240	2.068	1.919	.60	11.063	10″	2″	1″	3560.7	434.9	6.64	1370.6	170.0	4.12
288.0	16.563	16.18	1.36	12.240	2.161	2.013	.60	11.063	10″	2 1/16	1″	3788.4	457.5	6.69	1452.5	179.5	4.14
301.0	16.750	16.23	1.41	12.240	2.255	2.107	.60	11.063	10″	2 3/16	1″	4018.4	479.8	6.74	1533.2	188.9	4.16
314.0	16.938	16.28	1.46	12.240	2.349	2.201	.60	11.063	10″	2 1/4	1″	4254.5	502.4	6.78	1615.2	198.4	4.18
328.0	17.125	16.34	1.52	12.240	2.443	2.294	.60	11.063	10″	2 3/8	1″	4500.9	525.7	6.83	1701.8	208.3	4.20
342.0	17.313	16.40	1.58	12.240	2.536	2.388	.60	11.063	10″	2 7/16	1″	4754.0	549.2	6.87	1790.1	218.3	4.22
356.0	17.500	16.46	1.64	12.240	2.630	2.482	.60	11.063	10″	2 9/16	1″	5013.7	573.0	6.92	1880.0	228.4	4.24
370.0	17.688	16.52	1.70	12.240	2.724	2.576	.60	11.063	10″	2 5/8	1″	5280.2	597.1	6.96	1971.7	238.7	4.26
384.0	17.875	16.58	1.76	12.240	2.818	2.669	.60	11.063	10″	2 3/4	1″	5553.6	621.4	7.01	2065.1	249.1	4.27
399.0	18.063	16.64	1.82	12.240	2.911	2.763	.60	11.063	10″	2 13/16	1″	5834.0	646.0	7.05	2160.3	259.6	4.29
413.0	18.250	16.70	1.88	12.240	3.005	2.857	.60	11.063	10″	2 15/16	1″	6121.5	670.8	7.10	2257.2	270.3	4.31
427.0	18.438	16.76	1.94	12.240	3.099	2.951	.60	11.063	10″	3″	1″	6416.2	696.0	7.14	2355.9	281.1	4.33



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration



16″

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 16" BETHLEHEM H COLUMNS WITH COVER PLATES

2 Cover Plates	Weight per Foot	Area Square Inches	Least Radius Gyration	Unsupported Length in Feet: 18	20	22	24	26	28	30	32	34	36	38	40	42	44	48
16" × 293# BETHLEHEM H COLUMN																		
18 × 5/8	370	108.74	4.36	1631	1631	1626	1576	1523	1471	1420	1368	1317	1267	1218	1170	1123	1078	994
11/16	377	110.99	4.38	1665	1665	1663	1612	1558	1506	1453	1400	1349	1296	1248	1199	1151	1105	1019
3/4	385	113.24	4.40	1699	1699	1699	1647	1593	1540	1486	1432	1379	1327	1276	1228	1179	1132	1044
18 × 13/16	392	115.49	4.42	1732	1732	1732	1682	1628	1574	1519	1464	1411	1358	1306	1257	1207	1160	1069
7/8	400	117.74	4.43	1766	1766	1766	1715	1661	1606	1549	1495	1441	1387	1334	1282	1233	1184	1093
15/16	408	119.99	4.45	1800	1800	1800	1752	1697	1640	1584	1527	1472	1417	1364	1311	1261	1212	1118
18 × 1	415	122.24	4.46	1834	1834	1834	1786	1730	1672	1616	1559	1502	1446	1392	1339	1287	1237	1142
1 1/16	423	124.49	4.48	1867	1867	1867	1823	1765	1707	1649	1591	1534	1478	1422	1368	1316	1265	1168
1 1/8	431	126.74	4.49	1901	1901	1901	1857	1798	1739	1681	1622	1564	1506	1450	1395	1342	1290	1191
16" × 363# BETHLEHEM H COLUMN																		
18 × 5/8	440	129.36	4.42	1940	1940	1940	1883	1824	1763	1701	1640	1581	1521	1463	1407	1352	1299	1198
11/16	447	131.61	4.43	1974	1974	1974	1918	1857	1795	1732	1671	1611	1550	1491	1433	1378	1324	1221
3/4	455	133.86	4.44	2008	2008	2008	1953	1891	1829	1764	1703	1641	1580	1519	1460	1404	1349	1245
18 × 13/16	463	136.11	4.46	2042	2042	2042	1989	1926	1862	1799	1735	1673	1610	1550	1490	1433	1377	1271
7/8	470	138.36	4.47	2075	2075	2075	2023	1959	1894	1831	1765	1703	1640	1579	1518	1460	1403	1295
15/16	478	140.61	4.48	2109	2109	2109	2059	1994	1928	1863	1797	1732	1669	1606	1545	1486	1429	1319
18 × 1	486	142.86	4.49	2143	2143	2143	2093	2027	1960	1894	1829	1763	1697	1634	1573	1513	1454	1343
1 1/16	493	145.11	4.51	2177	2177	2177	2129	2063	1995	1929	1862	1795	1730	1666	1603	1543	1483	1370
1 1/8	501	147.36	4.52	2210	2210	2210	2165	2097	2029	1961	1894	1826	1759	1695	1631	1569	1509	1394
19 × 1 1/8	509	149.61	4.63	2244	2244	2244	2217	2150	2084	2015	1948	1882	1815	1750	1686	1623	1563	1448
1 3/16	517	151.99	4.64	2280	2280	2280	2254	2186	2119	2049	1980	1914	1847	1780	1716	1652	1591	1474
1 1/4	525	154.36	4.65	2315	2315	2315	2291	2223	2153	2084	2014	1946	1879	1811	1746	1681	1619	1500
19 × 1 5/16	533	156.74	4.67	2351	2351	2351	2329	2260	2191	2121	2052	1981	1912	1845	1777	1713	1650	1530
1 3/8	541	159.11	4.68	2387	2387	2387	2366	2298	2226	2156	2084	2014	1944	1874	1807	1742	1677	1555
1 7/16	549	161.49	4.69	2422	2422	2422	2403	2334	2262	2190	2119	2046	1975	1906	1838	1772	1705	1581
19 × 1 1/2	557	163.86	4.71	2458	2458	2458	2442	2371	2299	2227	2155	2081	2011	1940	1870	1802	1737	1611
1 9/16	565	166.24	4.72	2494	2494	2494	2479	2407	2334	2263	2188	2115	2041	1970	1900	1832	1765	1637
1 5/8	573	168.61	4.73	2529	2529	2529	2517	2445	2371	2296	2222	2148	2074	2001	1931	1861	1794	1664

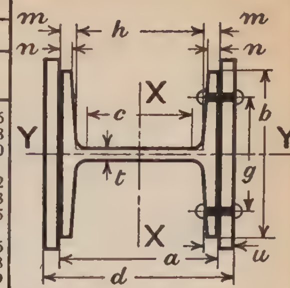
Loads to right of heavy vertical lines are for Secondary Members ONLY.

For 16" Bethlehem H Columns with 20" cover plates see following pages.

DIMENSIONS AND FUNCTIONS OF 16″ BETHLEHEM H COLUMNS WITH COVER PLATES

2 Cover Plates	Weight per Foot	Dimensions d	b	t	a	h	m	n	c	g	u	Riv.	Axis X-X I	S	r	Axis Y-Y I	S	r
16″ × 293# BETHLEHEM H COLUMN																		
18 × 5/8	370	17 5/8	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	2 5/8	1″	5311.5	602.7	6.99	2069.5	229.9	4.36
11/16	377	17 3/4	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	2 11/16	1″	5487.5	618.3	7.03	2130.2	236.7	4.38
3/4	385	17 7/8	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	2 3/4	1″	5665.9	633.9	7.07	2191.0	243.4	4.40
18 × 13/16	392	18	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	2 13/16	1″	5846.9	649.7	7.12	2251.7	250.2	4.42
7/8	400	18 1/8	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	2 7/8	1″	6030.4	665.4	7.16	2312.5	256.9	4.43
15/16	408	18 1/4	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	2 15/16	1″	6216.5	681.3	7.20	2373.2	263.7	4.45
18 × 1	415	18 3/8	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	3	1″	6405.1	697.2	7.24	2434.0	270.4	4.46
1 1/16	423	18 1/2	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	3 1/16	1″	6596.4	713.1	7.28	2494.7	277.2	4.48
1 1/8	431	18 5/8	16.46	1.64	16 3/8	12.24	2.068	1.919	11 1/16	10″	3 1/8	1″	6790.2	729.1	7.32	2555.5	283.9	4.49
16″ × 363# BETHLEHEM H COLUMN																		
18 × 5/8	440	18 9/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 1/16	1″	6720.2	724.1	7.21	2522.0	280.2	4.42
11/16	447	18 11/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 1/8	1″	6915.4	740.1	7.25	2582.8	287.0	4.43
3/4	455	18 13/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 3/16	1″	7113.1	756.2	7.29	2643.5	293.7	4.44
18 × 13/16	463	18 15/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 1/4	1″	7313.5	772.4	7.33	2704.3	300.5	4.46
7/8	470	19 1/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 5/16	1″	7516.6	788.6	7.37	2765.0	307.2	4.47
15/16	478	19 3/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 3/8	1″	7722.3	804.9	7.41	2825.8	314.0	4.48
18 × 1	486	19 5/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 7/16	1″	7930.8	821.3	7.45	2886.5	320.7	4.49
1 1/16	493	19 7/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 1/2	1″	8141.9	837.8	7.49	2947.3	327.5	4.51
1 1/8	501	19 9/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 9/16	1″	8355.8	854.3	7.53	3008.0	334.2	4.52
19 × 1 1/8	509	19 9/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 9/16	1″	8547.3	873.8	7.56	3200.6	336.9	4.63
1 3/16	517	19 11/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 5/8	1″	8775.9	891.5	7.60	3272.0	344.4	4.64
1 1/4	525	19 13/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 11/16	1″	9007.5	909.3	7.64	3343.5	351.9	4.65
19 × 1 5/16	533	19 15/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 3/4	1″	9242.1	927.1	7.68	3414.9	359.5	4.67
1 3/8	541	20 1/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 13/16	1″	9479.6	945.0	7.72	3486.4	367.0	4.68
1 7/16	549	20 3/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 7/8	1″	9720.1	963.0	7.76	3557.8	374.5	4.69
19 × 1 1/2	557	20 5/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	3 15/16	1″	9963.5	981.0	7.80	3629.3	382.0	4.71
1 9/16	565	20 7/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4″	1″	10210.0	999.1	7.84	3700.7	389.5	4.72
1 5/8	573	20 9/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 1/16	1″	10459.6	1017.3	7.88	3772.2	397.1	4.73

For 16″ Bethlehem H Columns with 20″ cover plates see following pages.



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

16″

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 16" BETHLEHEM H COLUMNS WITH COVER PLATES

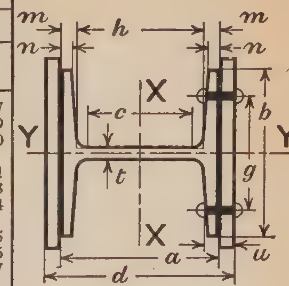
2 Cover Plates	Weight per Foot	Area Square Inches	Least Radius Gyration	Unsupported Length in Feet: 22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
16" × 363# BETHLEHEM H COLUMN																		
20 × 1 5/8	584	171.86	4.87	2578	2578	2519	2447	2373	2299	2226	2152	2080	2009	1940	1872	1805	1741	1679
1 11/16	593	174.36	4.89	2615	2615	2560	2486	2411	2338	2263	2190	2117	2043	1974	1904	1838	1771	1709
1 3/4	601	176.86	4.90	2653	2653	2598	2524	2448	2373	2297	2223	2149	2075	2006	1935	1868	1800	1737
20 × 1 13/16	610	179.36	4.91	2690	2690	2637	2561	2486	2411	2333	2258	2183	2107	2038	1966	1898	1829	1765
1 7/8	618	181.86	4.93	2728	2728	2677	2602	2526	2450	2371	2295	2219	2144	2071	1999	1930	1862	1795
1 15/16	627	184.36	4.94	2765	2765	2716	2640	2563	2485	2408	2328	2253	2177	2102	2030	1958	1890	1823
20 × 2	635	186.86	4.95	2803	2803	2754	2678	2599	2521	2442	2364	2285	2209	2134	2061	1988	1919	1852
2 1/16	644	189.36	4.96	2840	2840	2795	2715	2638	2556	2479	2399	2320	2242	2166	2092	2019	1949	1880
2 1/8	652	191.86	4.97	2878	2878	2834	2753	2675	2594	2513	2433	2352	2275	2199	2122	2049	1978	1909
20 × 2 3/16	661	194.36	4.99	2915	2915	2875	2795	2713	2632	2550	2470	2391	2311	2233	2157	2082	2010	1940
2 1/4	669	196.86	5.00	2953	2953	2914	2833	2752	2669	2587	2504	2423	2345	2266	2187	2112	2039	1969
2 5/16	678	199.36	5.01	2990	2990	2953	2871	2789	2705	2622	2538	2456	2376	2297	2219	2143	2069	1998
20 × 2 3/8	686	201.86	5.02	3028	3028	2992	2909	2826	2741	2658	2574	2491	2410	2329	2251	2174	2099	2027
2 7/16	695	204.36	5.03	3065	3065	3031	2949	2863	2779	2693	2610	2526	2442	2362	2283	2203	2127	2054
2 1/2	703	206.86	5.04	3103	3103	3070	2987	2900	2815	2728	2644	2559	2474	2393	2313	2234	2158	2083
20 × 2 9/16	712	209.36	5.05	3140	3140	3109	3025	2939	2851	2766	2680	2594	2508	2426	2345	2265	2188	2112
2 5/8	720	211.86	5.06	3178	3178	3148	3063	2977	2888	2801	2714	2627	2542	2458	2375	2294	2216	2140
2 11/16	729	214.36	5.06	3215	3215	3185	3100	3012	2922	2834	2746	2658	2572	2487	2403	2322	2242	2165
20 × 2 3/4	737	216.86	5.07	3253	3253	3225	3138	3049	2960	2871	2782	2693	2607	2520	2435	2353	2273	2195
2 13/16	746	219.36	5.08	3290	3290	3264	3176	3086	2996	2907	2817	2727	2639	2553	2468	2384	2303	2224
2 7/8	754	221.86	5.09	3328	3328	3303	3215	3126	3033	2942	2850	2760	2671	2585	2498	2414	2332	2254
20 × 2 15/16	763	224.36	5.10	3365	3365	3343	3253	3163	3071	2980	2888	2796	2706	2618	2531	2446	2363	2284
3	771	226.86	5.11	3403	3403	3382	3292	3201	3108	3015	2922	2829	2738	2650	2561	2477	2393	2312

Loads to right of heavy vertical lines are for Secondary Members ONLY.

For 16" Bethlehem H Columns with 18" and 19" cover plates see preceding pages.

DIMENSIONS AND FUNCTIONS OF 16″ BETHLEHEM H COLUMNS WITH COVER PLATES

2 Cover Plates	Weight per Foot	DIMENSIONS d	b	t	a	h	m	n	c	g	u	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
16″ × 363# BETHLEHEM H COLUMN																		
20 × 1 5/8	584	20 9/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 1/16	1″	10752	1045.7	7.91	4081.2	408.1	4.87
1 11/16	593	20 11/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 1/8	1″	11018	1065.1	7.95	4164.5	416.5	4.89
1 3/4	601	20 13/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 3/16	1″	11287	1084.6	7.99	4247.8	424.8	4.90
20 × 1 13/16	610	20 15/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 1/4	1″	11559	1104.1	8.03	4331.2	433.1	4.91
1 7/8	618	21 1/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 5/16	1″	11835	1123.8	8.07	4414.5	441.5	4.93
1 15/16	627	21 3/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 3/8	1″	12114	1143.5	8.11	4497.8	449.8	4.94
20 × 2	635	21 5/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 7/16	1″	12396	1163.2	8.14	4581.2	458.1	4.95
2 1/16	644	21 7/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 1/2	1″	12681	1183.1	8.18	4664.5	466.5	4.96
2 1/8	652	21 9/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 9/16	1″	12970	1203.0	8.22	4747.8	474.8	4.97
20 × 2 3/16	661	21 11/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 5/8	1″	13262	1223.0	8.26	4831.2	483.1	4.99
2 1/4	669	21 13/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 11/16	1″	13558	1243.2	8.30	4914.5	491.5	5.00
2 5/16	678	21 15/16	16.76	1.94	17 5/16	12.24	2.536	2.338	11 1/16	10″	4 3/4	1″	13857	1263.3	8.34	4997.8	499.8	5.01
20 × 2 3/8	686	22 1/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 13/16	1″	14160	1283.6	8.38	5081.2	508.1	5.02
2 7/16	695	22 3/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 7/8	1″	14466	1303.9	8.41	5164.5	516.5	5.03
2 1/2	703	22 5/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	4 15/16	1″	14775	1324.4	8.45	5247.8	524.8	5.04
20 × 2 9/16	712	22 7/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5	1″	15088	1344.9	8.49	5331.2	533.1	5.05
2 5/8	720	22 9/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5 1/16	1″	15404	1365.5	8.53	5414.5	541.5	5.06
2 11/16	729	22 11/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5 1/8	1″	15724	1386.2	8.56	5497.8	549.8	5.06
20 × 2 3/4	737	22 13/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5 3/16	1″	16048	1406.9	8.60	5581.2	558.1	5.07
2 13/16	746	22 15/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5 1/4	1″	16375	1427.8	8.64	5664.5	566.5	5.08
2 7/8	754	23 1/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5 5/16	1″	16705	1448.7	8.68	5747.8	574.8	5.09
20 × 2 15/16	763	23 3/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5 3/8	1″	17040	1469.7	8.71	5831.2	583.1	5.10
3	771	23 5/16	16.76	1.94	17 5/16	12.24	2.536	2.388	11 1/16	10″	5 7/16	1″	17378	1490.8	8.75	5914.5	591.5	5.11



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

For 16″ Bethlehem H Columns with 18″ and 19″ cover plates see preceding pages.

16″

NOTES and DIAGRAMS

Part IV
Section 11

Carnegie Columns

Dimensions

Technical Functions

Allowable Concentric Loads

by

A. I. S. C. Specification

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 4", 5", 6", 8" AND 9" ROLLED COLUMNS

CARNEGIE SMALL SECTIONS

Weight per foot	Area Sq. In.	Least Radius Gyration	Unsupported Length in Feet: 4	6	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30
4" CARNEGIE H BEAMS																						
13.8	3.99	0.95	60	54	46	42	38	35	32	29	26	24										
5" CARNEGIE H BEAMS																						
18.9	5.47	1.20	82	82	73	68	63	59	55	51	47	44	41	38	35	33	31					
6" CARNEGIE H BEAMS																						
20.0	5.86	1.39	88	88	83	79	75	70	66	62	58	55	51	48	45	42	40	35				
22.5	6.61	1.36	99	99	93	88	83	78	73	69	64	60	56	53	50	46	44	38				
25.0	7.33	1.43	110	110	106	100	95	90	84	79	75	70	66	62	58	55	51	46				
27.5	8.08	1.41	121	121	116	110	104	98	92	87	81	76	72	67	63	59	56	49				
8" CARNEGIE H BEAMS																						
32.6	9.50	1.90	143	143	143	143	140	135	130	124	119	114	109	104	100	95	91	83	75	68	62	57
34.3	10.00	1.87	150	150	150	150	146	141	136	130	124	119	114	108	103	99	94	85	78	71	64	59
37.7	11.00	1.83	165	165	165	165	160	154	147	141	135	129	123	117	112	106	101	92	83	76	69	63
8" AMERICAN STANDARD I BEAMS																						
18.4	5.34	0.84	80	68	56	50	45	41	37	33												
20.5	5.97	0.82	90	75	61	55	49	44	40	36												
8" CARNEGIE MILL SECTIONS																						
18.0	5.29	1.07	79	76	66	61	56	52	47	44	40	37	34	32								
21.0	6.17	1.03	93	87	75	69	63	58	53	49	45	41	38	35								
9" CARNEGIE MILL SECTIONS																						
21.0	6.17	1.14	93	91	80	74	69	64	59	54	50	45	43	40	37	34						
25.0	7.34	1.09	110	106	92	85	79	73	67	62	57	53	49	45	42							

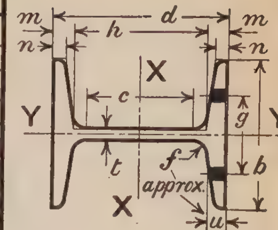
Loads to right of heavy vertical lines are for Secondary Members ONLY.

LOADS BY A. I. S. C. SPECIFICATION

DIMENSIONS AND FUNCTIONS OF 4", 5", 6", 8" AND 9" ROLLED COLUMNS

CARNEGIE SMALL SECTIONS

Weight per foot	DIMENSIONS											AXIS X-X			AXIS Y-Y		
	d	b	t	h	m	n	f	c	g	u	Riv.	I	S	r	I	S	r
4" CARNEGIE H BEAMS																	
13.8	4.000	4.000	.313	3.094	.453	.290	.31	2.522	2¼	⅜	¾	10.7	5.35	1.64	3.6	1.80	0.95
5" CARNEGIE H BEAMS																	
18.9	5.000	5.000	.313	3.994	.503	.330	.31	3.413	2¾	13/32	¾	23.8	9.52	2.08	7.8	3.12	1.20
6" CARNEGIE H BEAMS																	
20.0	6.000	5.938	.250	5.042	.479	.280	.31	4.458	3½	⅜	¾	38.8	12.93	2.57	11.4	3.84	1.39
22.5	6.000	6.063	.375	5.042	.479	.280	.31	4.458	3½	⅜	¾	41.0	13.67	2.49	12.2	4.02	1.36
25.0	6.000	5.938	.313	4.840	.580	.381	.31	4.256	3½	15/32	¾	47.0	15.67	2.53	14.9	5.02	1.43
27.5	6.000	6.063	.438	4.840	.580	.381	.31	4.256	3½	15/32	¾	49.3	16.43	2.47	16.0	5.28	1.41
8" CARNEGIE H BEAMS																	
32.6	8.000	7.938	.313	6.880	.560	.358	.31	6.287	5½	15/32	⅞	112.8	28.20	3.45	34.2	8.62	1.90
34.3	8.000	8.000	.375	6.880	.560	.358	.31	6.287	5½	15/32	⅞	115.5	28.88	3.40	35.1	8.78	1.87
37.7	8.000	8.125	.500	6.880	.560	.358	.31	6.287	5½	15/32	⅞	120.8	30.20	3.31	36.9	9.08	1.83
8" AMERICAN STANDARD I BEAMS																	
18.4	8.000	4.000	.270	6.838	.581	.270	.37	6.211	2¼	7/16	¾	56.9	14.22	3.26	3.8	1.90	.84
20.5	8.000	4.080	.349	6.838	.581	.270	.37	6.211	2¼	7/16	¾	60.2	15.05	3.18	4.0	2.00	.82
8" CARNEGIE MILL SECTIONS																	
18.0	8.000	5.000	.250	7.108	.446	.238	.25	6.608	2¾	5/16	¾	58.7	14.68	3.33	6.1	2.44	1.07
21.0	8.000	5.110	.360	7.108	.446	.238	.25	6.608	2¾	5/16	¾	63.4	15.85	3.21	6.6	2.58	1.03
9" CARNEGIE MILL SECTIONS																	
21.0	9.000	5.250	.250	8.008	.496	.277	.28	7.458	2¾	⅜	¾	87.6	19.47	3.77	8.1	3.09	1.14
25.0	9.000	5.380	.380	8.008	.496	.277	.28	7.458	2¾	⅜	¾	95.5	21.22	3.61	8.8	3.27	1.09



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

4" to 9"

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 8″ AND 9″ ROLLED COLUMNS

CARNEGIE SECTIONS

Weight per foot	Area Sq. In.	Least Radius Gyration	UNSUPPORTED LENGTH IN FEET																			
			4	6	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30
8″ AMERICAN STANDARD I BEAMS																						
18 4	5.34	.84	80	68	56	50	45	41	37	33												
20.5	5.97	.82	90	75	61	55	49	44	40	36												
8″ CARNEGIE H BEAMS																						
32.6	9 50	1 90	143	143	143	143	140	135	130	124	119	114	109	104	100	95	91	83	75	68	62	57
34.3	10.00	1.87	150	150	150	150	146	141	136	130	124	119	114	108	103	99	94	85	78	71	64	59
37.7	11 00	1 83	165	165	165	165	160	154	147	141	135	129	123	117	112	106	101	92	83	76	69	63
8″ CARNEGIE BEAM SECTIONS																						
24.0	7.06	1.61	106	106	106	102	97	93	88	84	79	75	71	67	64	60	57	51	46	41		
27.0	7.93	1.62	119	119	119	114	109	104	99	94	89	85	80	76	72	68	64	58	52	47		
30.0	8.81	1.63	132	132	132	127	122	116	111	105	100	95	90	85	80	76	72	65	58	52		
31.0	9.10	2.01	137	137	137	137	137	132	127	123	118	113	109	104	100	96	91	84	77	70	64	59
36.0	10.58	2.02	159	159	159	159	159	154	149	143	138	132	127	122	116	112	107	98	89	82	75	69
42.0	12.34	2.04	185	185	185	185	185	180	174	168	161	155	149	143	137	131	126	115	105	97	89	81
48.0	14.10	2.06	212	212	212	212	212	207	200	192	185	178	171	164	158	151	145	133	122	112	102	94
54.0	15.87	2.07	238	238	238	238	238	233	225	217	209	201	193	186	178	171	164	150	138	126	116	107
60.0	17.63	2.09	264	264	264	264	264	260	251	242	234	225	216	208	199	191	183	168	154	142	130	120
66.0	19.40	2.11	291	291	291	291	291	287	277	268	258	249	239	230	221	212	203	187	172	158	145	133
72.0	21.17	2.12	318	318	318	318	318	314	303	293	282	272	262	252	242	232	223	205	188	173	159	146
78.0	22.93	2.14	344	344	344	344	344	341	330	319	307	296	285	274	264	253	243	224	206	189	174	160
84.0	24.71	2.15	371	371	371	371	371	368	356	344	332	320	308	296	285	274	263	242	223	205	189	174
90.0	26.47	2.17	397	397	397	397	397	395	383	370	357	345	332	320	307	295	284	261	241	222	204	188
9″ CARNEGIE BEAM SECTIONS																						
29.0	8.53	1.59	128	128	128	122	117	111	105	100	95	90	85	80	76	72	68	61	54	49		
32.0	9.40	1.60	141	141	141	135	129	123	117	111	105	99	94	89	84	80	75	67	60	54		
35.0	10 29	1.61	154	154	154	148	142	135	128	122	115	109	103	98	93	88	83	74	67	60		
38.0	11.17	2.26	168	168	168	168	168	168	164	159	154	149	144	138	133	128	124	114	106	95	90	83
43.0	12.65	2.28	190	190	190	190	190	190	186	181	175	169	163	157	152	146	141	130	120	111	103	95
48.0	14 11	2.29	212	212	212	212	212	212	208	202	196	189	183	176	170	164	158	146	135	125	116	107

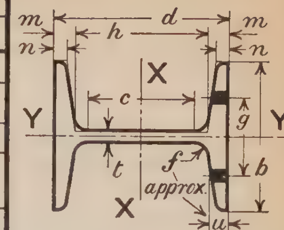
Loads to right of heavy vertical lines are for Secondary Members ONLY.

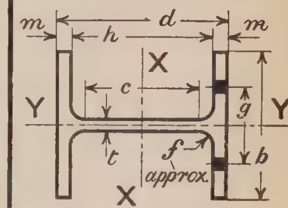
DIMENSIONS AND FUNCTIONS OF 8″ AND 9″ ROLLED COLUMNS

CARNEGIE SECTIONS

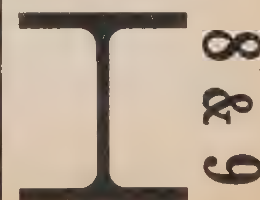
Weight per foot	DIMENSIONS d	b	t	h	m	n	f	c	g	u	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
8″ AMERICAN STANDARD I BEAMS																	
18.4	8.000	4.000	.270	6.838	.581	.270	.37	6.211	2¼	7/16	¾	56.9	14.22	3.26	3.8	1.90	.84
20.5	8 000	4.080	.349	6.838	.581	.270	.37	6.211	2¼	7/16	¾	60.2	15 05	3.18	4.0	2.00	.82
8″ CARNEGIE H BEAMS																	
32.6	8 000	7.938	.313	6 880	.560	.358	.31	6.287	5½	15/32	⅞	112.8	28.20	3.45	34.2	8 62	1.90
34.3	8.000	8.000	.375	6 880	.560	.358	.31	6.287	5½	15/32	⅞	115.5	28.88	3.40	35.1	8.78	1.87
37.7	8 000	8.125	.500	6 880	.560	.358	.31	6.287	5½	15/32	⅞	120 8	30 20	3.31	36 9	9 08	1.83
*** 8″ CARNEGIE BEAM SECTIONS**																	
24.0	8.000	6.500	.239	7.200	.400		.45	6.300	3½		⅞	84.3	21.08	3 46	18.3	5.63	1.61
27.0	8.098	6.529	.268	7.200	.449		45	6.300	3½		⅞	95.9	23.68	3.48	20.8	6.37	1.62
30.0	8.196	6.559	.298	7.200	.498		.45	6.300	3½		⅞	107.8	26.31	3.50	23.4	7.14	1.63
31.0	8.060	8.000	.290	7 200	.430		.45	6.300	5½		⅞	110.9	27.52	3 49	36.7	9.18	2.01
36.0	8.198	8 046	.336	7.200	.499		.45	6 300	5½		⅞	131.3	32.03	3.52	43.4	10.79	2.02
42.0	8.360	8.100	.390	7.200	.580		.45	6.300	5½		⅞	156.2	37.37	3.56	51.4	12.69	2.04
48.0	8.520	8 155	445	7.200	.660		.45	6 300	5½		⅞	182.2	42.77	3.59	59.7	14.64	2.06
54.0	8 680	8.208	.498	7 200	.740		.45	6.300	5½		⅞	209.2	48.20	3.63	68.3	16.64	2.07
60.0	8.838	8.261	.551	7.200	.819		.45	6 300	5½		⅞	237.1	53.65	3.67	77.1	18.67	2 09
66.0	8.994	8.314	.604	7.200	.897		.45	6 300	5½		⅞	265.9	59.13	3.70	86.1	20.71	2 11
72.0	9.150	8.366	.656	7.200	.975		.45	6.300	5½		⅞	295.9	64.68	3.74	95.3	22.78	2.12
78.0	9.302	8.418	.708	7.200	1.051		.45	6 300	5½		⅞	326.5	70.20	3.77	104.7	24 88	2.14
84.0	9.456	8.469	.759	7.200	1.128		.45	6 300	5½		⅞	358.6	75.85	3.81	114.5	27 04	2.15
90.0	9.606	8 520	.810	7 200	1.203		45	6 300	5½		⅞	391.2	81.45	3.84	124.4	29.20	2.17
*** 9″ CARNEGIE BEAM SECTIONS**																	
29 0	9.000	6.500	.279	8 060	.470		.50	7.060	3½		⅞	126.0	28 00	3.84	21.5	6.62	1.59
32.0	9 096	6.528	.307	8 060	.518		.50	7.060	3½		⅞	140.5	30.89	3.87	24.0	7.35	1.60
35.0	9.192	6.556	.335	8 060	.566		.50	7.060	3½		⅞	155.4	33.81	3.89	26.6	8.11	1.61
38.0	9.000	9.000	.316	8.060	.470		.50	7 060	5½		⅞	170.4	37.87	3.91	57.1	12.69	2.26
43 0	9 122	9 041	.357	8 060	.531		.50	7.060	5½		⅞	195.5	42.86	3.93	65.4	14.47	2.28
48.0	9 242	9 082	398	8 060	.591		.50	7 060	5½		⅞	221.1	47.85	3.96	73.8	16.25	2.29

*CARNEGIE BEAM SECTIONS have flanges of uniform thickness throughout their width.





I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration



ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 10″ ROLLED COLUMNS

CARNEGIE SECTIONS

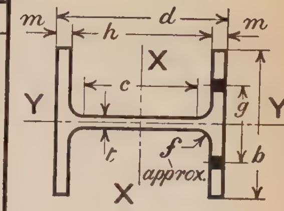
Weight per foot	Area Sq. In.	Least Radius Gyration	UNSUPPORTED LENGTH IN FEET																			
			8	10	12	13	14	15	16	17	18	19	20	22	24	26	28	30	32	34	36	38
10″ CARNEGIE BEAM SECTIONS																						
21	6.17	1.39	88	79	70	65	61	57	54	51	47	45	42	37								
23	6.76	1.43	97	87	78	73	69	65	61	57	54	50	47	42								
26	7.64	1.43	110	99	88	83	78	73	69	65	61	57	54	48	42							
30	8.82	1.45	128	115	103	97	91	86	80	76	71	69	63	56	50							
31	9.11	1.89	137	134	124	119	114	109	104	100	95	91	86	79	72	65	60	54				
36	10.58	1.80	159	153	140	134	128	122	117	111	106	101	96	87	79	71	65	59				
42	12.35	1.73	185	175	161	153	146	139	132	125	119	113	107	97	88	79	72					
49	14.40	2.54	216	216	216	214	209	203	197	191	185	179	173	162	151	141	131	123	114	107	99	93
54	15.87	2.48	238	238	238	234	228	221	214	208	201	194	188	175	163	152	141	132	123	114	106	99
59	17.34	2.42	260	260	260	254	246	239	231	224	216	209	202	188	175	162	151	140	130	121	113	105
64	18.81	2.38	282	282	281	273	265	257	249	240	232	224	216	201	187	173	161	149	138	129	120	111
70	20.59	2.55	309	309	309	307	299	290	282	273	265	257	248	232	217	202	189	176	164	153	143	133
77	22.65	2.51	340	340	340	336	326	317	308	298	289	280	270	253	235	219	204	190	177	165	154	144
84	24.70	2.48	371	371	371	364	354	344	334	323	313	303	292	273	254	237	220	205	191	178	166	154
92	27.06	2.50	406	406	406	400	389	378	367	356	344	333	322	301	280	261	243	226	211	196	183	171
100	29.40	3.16	441	441	441	441	441	441	439	430	420	410	401	381	362	343	325	307	291	275	260	245
108	31.76	3.13	476	476	476	476	476	476	473	463	452	442	431	410	389	368	349	330	311	294	278	262
116	34.11	3.11	512	512	512	512	512	512	507	496	484	473	461	438	416	394	372	352	332	314	296	280
124	36.46	3.09	547	547	547	547	547	547	540	528	516	504	492	467	443	419	396	374	353	333	315	297
132	38.81	3.09	582	582	582	582	582	582	575	562	549	536	523	497	472	446	422	398	376	355	335	316
140	41.17	3.08	618	618	618	618	618	618	609	596	582	568	554	526	499	472	446	421	398	375	354	334

Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 10″ ROLLED COLUMNS

CARNEGIE SECTIONS

Weight per foot	DIMENSIONS									AXIS X-X			AXIS Y-Y		
	d	b	t	h	m	f	c	g	Riv.	I	S	r	I	S	r
10″ CARNEGIE BEAM SECTIONS															
21	9.902	6.000	.230	9.238	.332	.30	8.638	3″	¾	107.6	21.7	4.18	12.0	4.0	1.39
23	10.000	6.000	.230	9.238	.381	.30	8.638	3″	¾	122.2	24.4	4.25	13.7	4.6	1.43
26	10.098	6.029	.259	9.238	.430	.30	8.638	3″	¾	139.5	27.6	4.27	15.7	5.2	1.43
30	10.228	6.068	.298	9.238	.495	.30	8.638	3″	¾	163.2	31.9	4.30	18.5	6.1	1.45
31	10.000	8.000	.320	9.238	.381	.30	8.638	5½	⅞	163.4	32.7	4.23	32.5	8.1	1.89
36	10.000	8.147	.467	9.238	.381	.30	8.638	5½	⅞	175.6	35.1	4.07	34.4	8.5	1.80
42	10.000	8.324	.644	9.238	.381	.30	8.638	5½	⅞	190.4	38.1	3.93	36.8	8.9	1.73
49	10.000	10.000	.350	8.884	.558	.45	7.984	5½	⅞	272.0	54.4	4.35	93.0	18.6	2.54
54	10.000	10.147	.497	8.884	.558	.45	7.984	5½	⅞	284.3	56.9	4.23	97.3	19.2	2.48
59	10.000	10.294	.644	8.884	.558	.45	7.984	5½	⅞	296.5	59.3	4.13	101.7	19.8	2.42
64	10.000	10.441	.791	8.884	.558	.45	7.984	5½	⅞	308.8	61.8	4.05	106.3	20.4	2.38
70	10.000	10.000	.515	8.390	.805	.50	7.390	5½	⅞	369.3	73.9	4.24	134.3	26.9	2.55
77	10.000	10.206	.721	8.390	.805	.50	7.390	5½	⅞	386.5	77.3	4.13	142.9	28.0	2.51
84	10.000	10.411	.926	8.390	.805	.50	7.390	5½	⅞	403.6	80.7	4.04	152.0	29.2	2.48
92	10.000	10.647	1.162	8.390	.805	.50	7.390	5½	⅞	423.2	84.6	3.96	163.1	30.6	2.50
100	10.000	12.000	.600	7.968	1.016	.60	6.768	9″	1″	525.1	105.0	4.23	292.8	48.8	3.16
108	10.000	12.236	.836	7.968	1.016	.60	6.768	9″	1″	544.8	109.0	4.14	310.7	50.8	3.13
116	10.000	12.471	1.071	7.968	1.016	.60	6.768	9″	1″	564.3	112.9	4.07	329.4	52.8	3.11
124	10.000	12.706	1.306	7.968	1.016	.60	6.768	9″	1″	583.9	116.8	4.00	349.0	54.9	3.09
132	10.000	12.941	1.541	7.968	1.016	.60	6.768	9″	1″	603.5	120.7	3.94	369.6	57.1	3.09
140	10.000	13.177	1.777	7.968	1.016	.60	6.768	9″	1″	623.2	124.6	3.89	391.4	59.4	3.08



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

10″

ALLOWABLE CONCENTRIC LOAD IN KIPS FOR 12" ROLLED COLUMNS

CARNEGIE SECTIONS

Weight per foot	Area Sq. In.	Least Radius Gyration	UNSUPPORTED LENGTH IN FEET																			
			8	10	12	14	15	16	17	18	19	20	22	24	26	28	30	32	34	36	38	40
12" CARNEGIE BEAM SECTIONS																						
25	7.34	1.37	104	93	82	72	67	63	59	55	52	49	43									
28	8.22	1.53	121	110	99	89	84	79	74	70	66	63	56	50								
32	9.40	1.54	139	127	114	102	96	91	86	81	76	72	64	57								
† 34	9.99	1.45	145	130	116	103	97	91	86	81	76	71	63	56								
36	10.59	1.55	157	143	129	115	109	103	97	92	87	82	73	65								
40	11.76	1.95	176	175	163	150	144	138	132	125	121	115	105	96	88	80	73	67				
45	13.23	1.97	198	197	184	170	163	156	149	143	137	131	119	109	99	91	83	77				
50	14.69	1.98	220	220	204	189	181	174	166	159	152	146	133	122	111	102	93	86				
55	16.17	2.24	243	243	237	222	214	207	199	192	185	178	164	152	140	129	120	111	102	95		
60	17.65	2.25	265	265	259	243	234	226	218	210	202	195	180	166	154	142	131	121	112	104		
66	19.41	2.26	291	291	285	267	258	249	241	232	223	215	199	184	170	157	145	134	124	115		
65	19.11	3.03	287	287	287	287	287	281	275	268	262	255	242	229	216	204	193	182	171	162	152	144
70	20.58	2.96	309	309	309	309	307	300	293	286	279	271	257	243	229	216	203	191	180	170	160	151
76	22.35	2.90	335	335	335	335	331	324	316	308	299	291	275	260	245	230	217	204	192	180	169	160
82	24.11	3.09	362	362	362	362	362	357	349	341	333	325	309	293	277	262	247	234	220	208	196	185
88	25.88	3.04	388	388	388	388	388	381	373	364	355	346	328	311	294	278	262	247	233	220	207	195
95	27.93	2.99	419	419	419	419	418	409	399	390	380	370	351	332	313	295	278	262	247	233	219	207
102	29.99	2.95	450	450	450	450	447	437	427	416	405	395	374	353	333	314	295	278	262	246	232	218
110	32.34	3.10	485	485	485	485	485	480	469	458	448	437	415	393	373	352	333	314	297	280	264	250
120	35.28	3.06	529	529	529	529	529	521	509	497	485	473	449	426	403	380	359	339	319	301	284	268
130	38.24	3.03	574	574	574	574	574	563	550	537	524	510	484	458	433	409	386	364	343	323	305	287
140	41.18	3.01	618	618	618	618	618	605	591	576	562	548	519	491	464	438	413	389	367	346	326	307
150	44.12	3.69	662	662	662	662	662	662	662	662	655	643	618	593	568	544	519	496	473	451	430	409
160	47.06	3.67	706	706	706	706	706	706	706	706	698	684	658	631	604	578	552	527	502	479	456	434
170	50.00	3.65	750	750	750	750	750	750	750	750	740	726	697	669	640	612	584	557	531	506	482	459
180	52.94	3.64	794	794	794	794	794	794	794	794	782	768	737	707	677	647	617	589	561	535	509	485
190	55.88	3.71	838	838	838	838	838	838	838	838	831	816	785	754	722	691	660	631	602	574	547	521
200	58.82	3.71	882	882	882	882	882	882	882	882	875	859	826	793	760	727	695	664	633	604	576	549
210	61.76	3.72	926	926	926	926	926	926	926	926	920	903	869	834	799	765	731	698	666	636	606	578
220	64.70	3.73	971	971	971	971	971	971	971	971	964	947	911	875	839	803	767	733	700	667	636	607
230	67.64	3.74	1015	1015	1015	1015	1015	1015	1015	1015	1009	991	954	916	878	841	804	768	733	699	667	636

Loads to right of heavy vertical lines are for Secondary Members ONLY.

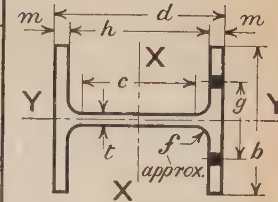
† Special Section. Web Thickness 3/8".

DIMENSIONS AND FUNCTIONS OF 12″ ROLLED COLUMNS

CARNEGIE SECTIONS

Weight per foot	Dimensions: d	b	t	h	m	f	c	g	Riv.	Axis X-X: I	S	r	Axis Y-Y: I	S	r
12″ CARNEGIE BEAM SECTIONS															
25	11.924	6.600	.240	11.160	0.382	.35	10.460	3″	¾	183.0	30.7	4.99	13.8	4.6	1.37
28	12.000	6.500	.240	11.160	.420	.35	10.460	3″	¾	213.4	35.6	5.10	19.2	5.9	1.53
32	12.118	6.534	.274	11.160	.479	.35	10.460	3″	¾	246.3	40.7	5.12	22.3	6.8	1.54
†34	12.022	6.635	.375	11.160	.431	.35	10.460	3″	¾	238.1	39.6	4.88	21.0	6.3	1.45
36	12.236	6.568	.308	11.160	.538	.35	10.460	3″	¾	280.1	45.8	5.14	25.4	7.7	1.55
40	12.000	8.000	.290	10.948	.526	.50	9.948	5½	⅞	313.7	52.3	5.17	44.9	11.2	1.95
45	12.130	8.036	.326	10.948	.591	.50	9.948	5½	⅞	356.9	58.8	5.19	51.2	12.7	1.97
50	12.258	8.071	.361	10.948	.655	.50	9.948	5½	⅞	400.5	65.4	5.22	57.5	14.2	1.98
55	12.000	9.000	.375	10.670	.665	.55	9.570	5½	⅞	428.4	71.4	5.15	80.9	18.0	2.24
60	12.118	9.034	.409	10.670	.724	.55	9.570	5½	⅞	472.0	77.9	5.17	89.0	19.7	2.25
66	12.260	9.073	.448	10.670	.795	.55	9.570	5½	⅞	525.7	85.8	5.20	99.1	21.8	2.26
65	12.000	12.000	.400	10.784	.608	.55	9.684	9″	1″	521.3	86.9	5.22	175.2	29.2	3.03
70	12.000	12.123	.523	10.784	.608	.55	9.684	9″	1″	539.0	89.8	5.12	180.7	29.8	2.96
76	12.000	12.270	.670	10.784	.608	.55	9.684	9″	1″	560.2	93.4	5.01	187.5	30.6	2.90
82	12.000	12.000	.453	10.400	.800	.55	9.300	9″	1″	650.8	108.5	5.20	230.5	38.4	3.09
88	12.000	12.147	.600	10.400	.800	.55	9.300	9″	1″	672.0	112.0	5.10	239.2	39.4	3.04
95	12.000	12.318	.771	10.400	.800	.55	9.300	9″	1″	696.6	116.1	4.99	249.7	40.5	2.99
102	12.000	12.490	.943	10.400	.800	.55	9.300	9″	1″	721.4	120.2	4.90	260.6	41.7	2.95
110	12.000	12.000	.640	9.850	1.075	.60	8.650	9″	1″	828.8	138.1	5.06	309.9	51.6	3.10
120	12.000	12.245	.885	9.850	1.075	.60	8.650	9″	1″	864.1	144.0	4.95	329.6	53.8	3.06
130	12.000	12.491	1.131	9.850	1.075	.60	8.650	9″	1″	899.5	149.9	4.85	350.5	56.1	3.03
140	12.000	12.736	1.376	9.850	1.075	.60	8.650	9″	1″	934.8	155.8	4.76	372.4	58.5	3.01
150	12.000	14.000	.757	9.376	1.312	.65	8.076	10″	1″	1112.2	185.4	5.02	600.4	85.8	3.69
160	12.000	14.245	1.002	9.376	1.312	.65	8.076	10″	1″	1147.5	191.3	4.94	633.0	88.9	3.67
170	12.000	14.490	1.247	9.376	1.312	.65	8.076	10″	1″	1182.8	197.1	4.86	666.9	92.1	3.65
180	12.000	14.735	1.492	9.376	1.312	.65	8.076	10″	1″	1218.1	203.0	4.80	702.4	95.3	3.64
190	12.000	14.000	1.000	8.646	1.677	.65	7.346	10″	1″	1320.8	220.1	4.86	767.8	109.7	3.71
200	12.000	14.245	1.245	8.646	1.677	.65	7.346	10″	1″	1356.1	226.0	4.80	809.5	113.7	3.71
210	12.000	14.490	1.490	8.646	1.677	.65	7.346	10″	1″	1391.3	231.9	4.75	852.9	117.7	3.72
220	12.000	14.735	1.735	8.646	1.677	.65	7.346	10″	1″	1426.6	237.8	4.70	898.2	121.9	3.73
230	12.000	14.980	1.980	8.646	1.677	.65	7.346	10″	1″	1461.9	243.7	4.65	945.5	126.2	3.74

† Special Section. Web Thickness ⅜″



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

12″

ALLOWABLE CONCENTRIC LOAD IN KIPS FOR 14″ ROLLED COLUMNS

CARNEGIE SECTIONS

Weight per foot	Area Sq. In.	Least Radius Gyration	8	10	12	14	15	16	17	18	19	20	22	24	26	28	30	32	34	36	38	40
			UNSUPPORTED LENGTH IN FEET																			
			14″ CARNEGIE BEAM SECTIONS																			
30	8.82	1.33	123	109	96	84	79	74	69	64	60	57	50									
33	9.71	1.54	144	131	118	105	99	94	88	84	79	74	66	59								
36	10.58	1.55	157	143	129	115	109	103	97	92	86	82	73	65								
† 38	11.18	1.47	163	147	131	117	110	103	97	91	86	81	72	64								
39	11.47	1.56	171	155	140	126	119	112	106	100	94	89	80	71	64							
42	12.35	1.56	184	167	151	135	128	121	114	108	102	96	86	77	69							
48	14.12	1.90	212	208	193	177	170	162	155	148	141	135	123	112	102	93	85					
53	15.59	1.91	234	230	213	196	188	180	172	164	157	149	136	124	113	103	94					
58	17.05	1.92	256	252	234	215	206	197	189	180	172	164	150	136	124	114	104	95				
61	17.94	2.44	269	269	269	256	248	240	233	225	217	210	196	182	169	157	146	136	126			
68	19.99	2.46	300	300	300	286	277	269	260	252	244	235	219	204	190	177	164	153	142			
75	22.05	2.47	331	331	331	316	306	297	288	279	269	260	243	226	210	196	182	169	158			
85	24.99	3.05	375	375	375	375	375	369	360	352	343	335	318	301	284	269	254	239	226			
95	27.93	3.06	419	419	419	419	419	413	403	394	384	375	356	337	319	301	284	268	253			
105	30.88	3.08	463	463	463	463	463	457	447	437	426	416	395	374	354	335	316	298	281			
86	25.28	3.84	379	379	379	379	379	379	379	379	379	374	360	347	333	319	306	293	280	267	255	244
96	28.23	3.86	423	423	423	423	423	423	423	423	423	418	403	388	373	358	343	328	314	300	286	273
106	31.18	3.87	468	468	468	468	468	468	468	468	468	462	446	429	412	396	379	363	347	332	317	303
115	33.82	3.89	507	507	507	507	507	507	507	507	507	502	485	467	448	430	413	395	378	361	345	330
125	36.75	3.90	551	551	551	551	551	551	551	551	551	547	527	508	488	468	449	430	411	393	376	359
‡ 131	38.52	3.77	578	578	578	578	578	578	578	578	576	566	545	524	502	481	460	440	420	401	382	365
135	39.70	3.92	596	596	596	596	596	596	596	596	596	591	570	549	528	507	486	466	446	426	407	389
145	42.64	3.93	640	640	640	640	640	640	640	640	640	636	614	591	568	546	523	502	480	459	439	420
155	45.58	3.94	684	684	684	684	684	684	684	684	684	680	657	633	608	584	560	537	514	492	470	450
165	48.52	3.96	728	728	728	728	728	728	728	728	728	725	700	675	649	624	599	574	549	526	503	481
175	51.47	3.97	772	772	772	772	772	772	772	772	772	770	744	717	690	663	636	610	584	559	535	511
185	54.41	3.98	816	816	816	816	816	816	816	816	816	815	787	759	731	702	674	646	619	593	567	542
195	57.34	4.00	860	860	860	860	860	860	860	860	860	860	831	801	771	741	712	683	654	626	599	573
205	60.28	4.01	904	904	904	904	904	904	904	904	904	904	874	843	812	781	749	719	689	660	631	604
215	63.23	4.03	949	949	949	949	949	949	949	949	949	949	919	886	853	821	788	756	725	694	664	636
225	66.17	4.04	993	993	993	993	993	993	993	993	993	993	963	929	895	860	826	793	760	728	697	668
235	69.11	4.05	1037	1037	1037	1037	1037	1037	1037	1037	1037	1037	1006	971	936	900	864	830	795	762	730	699
245	72.06	4.06	1081	1081	1081	1081	1081	1081	1081	1081	1081	1081	1051	1014	977	940	903	867	832	797	763	731
255	74.99	4.08	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1095	1057	1019	980	942	905	868	832	797	763
265	77.93	4.09	1169	1169	1169	1169	1169	1169	1169	1169	1169	1169	1139	1100	1060	1020	981	942	903	866	830	795

NOTE: For the convenience of the designer beams from 68 lb. to 265 lb. per foot are duplicated on the following page in conjunction with those from 275 lb. to 425 lb. per foot.

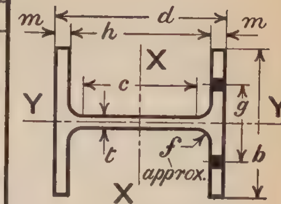
Loads to right of heavy vertical lines are for Secondary Members ONLY. † Special Section: Web Thickness ⅜″. ‡ Special Section for Column Core.

DIMENSIONS AND FUNCTIONS OF 14″ ROLLED COLUMNS — CARNEGIE SECTIONS

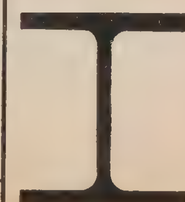
Weight per foot	DIMENSIONS d	b	t	h	m	f	c	g	Riv.	AXIS X - X I	S	r	AXIS Y - Y I	S	r
14″ CARNEGIE BEAM SECTIONS															
30	13.964	6.000	.270	13.102	.431	40	12.302	3″	¾	292.0	41.8	5.75	15.5	5.2	1.33
33	14.000	6.750	270	13.102	449	40	12.302	3″	¾	333.4	47.6	5.86	23.0	6.8	1.54
36	14.080	6.774	.294	13.102	.489	.40	12.302	3″	¾	365.6	51.9	5.88	25.4	7.5	1.55
†38	14.000	6.855	.375	13.102	.449	.40	12.302	3″	¾	357.5	51.1	5.66	24.2	7.1	1.47
39	14.160	6.798	.318	13.102	.529	.40	12.302	3″	¾	398.3	56.3	5.89	27.7	8.2	1.56
42	14.240	6.822	.342	13.102	.569	.40	12.302	3″	¾	431.5	60.6	5.91	30.2	8.8	1.56
48	14.000	8.000	.343	12.810	.595	.55	11.710	5½	⅞	496.0	70.9	5.93	50.8	12.7	1.90
53	14.122	8.035	.378	12.810	.656	.55	11.710	5½	⅞	552.5	78.2	5.95	56.8	14.1	1.91
58	14.242	8.070	.413	12.810	.716	.55	11.710	5½	⅞	609.4	85.6	5.98	62.8	15.6	1.92
61	14.094	10.000	.382	12.810	.642	.55	11.710	5½	1″	656.2	93.1	6.05	107.1	21.4	2.44
68	14.238	10.043	.425	12.810	.714	.55	11.710	5½	1″	738.8	103.8	6.08	120.6	24.0	2.46
75	14.382	10.086	.468	12.810	.786	.55	11.710	5½	1″	823.5	114.5	6.11	134.5	26.7	2.47
85	14.000	12.000	.435	12.390	.805	.65	11.090	9″	1″	921.3	131.6	6.07	232.0	38.7	3.05
95	14.186	12.050	.485	12.390	.898	.65	11.090	9″	1″	1044.0	147.2	6.11	262.0	43.5	3.06
105	14.370	12.101	.536	12.390	.990	.65	11.090	9″	1″	1169.6	162.8	6.15	292.6	48.4	3.08
86	13.714	15.008	.414	12.390	.662	.65	11.090	10″	1″	923.0	136.6	6.04	373.1	49.7	3.84
96	13.866	15.056	.462	12.390	.738	.65	11.090	10″	1″	1042.1	150.3	6.08	419.9	55.8	3.86
106	14.018	15.103	.509	12.390	.814	.65	11.090	10″	1″	1164.1	166.1	6.11	467.6	61.9	3.87
115	14.154	15.145	.551	12.390	.882	.65	11.090	10″	1″	1275.9	180.3	6.14	510.9	67.5	3.89
125	14.304	15.191	.597	12.390	.957	.65	11.090	10″	1″	1402.1	196.0	6.18	559.4	73.7	3.90
‡131	14.162	15.468	.874	12.390	.886	.65	11.090	10″	1″	1358.4	191.8	5.94	547.3	70.8	3.77
135	14.452	15.239	.645	12.390	1.031	.65	11.090	10″	1″	1530.4	211.8	6.21	608.4	79.9	3.92
145	14.602	15.284	.690	12.390	1.106	.65	11.090	10″	1″	1662.7	227.7	6.24	658.5	86.2	3.93
155	14.750	15.330	736	12.390	1.180	.65	11.090	10″	1″	1796.8	243.6	6.28	709.0	92.5	3.94
165	14.896	15.377	.783	12.390	1.253	.65	11.090	10″	1″	1932.6	259.5	6.31	759.9	98.8	3.96
175	15.042	15.424	.830	12.390	1.326	.65	11.090	10″	1″	2071.7	275.5	6.34	811.6	105.2	3.97
185	15.188	15.469	.875	12.390	1.399	.65	11.090	10″	1″	2213.5	291.5	6.38	863.9	111.7	3.98
195	15.334	15.513	.919	12.390	1.472	.65	11.090	10″	1″	2358.2	307.6	6.41	916.8	118.2	4.00
205	15.478	15.559	.965	12.390	1.544	.65	11.090	10″	1″	2505.0	323.7	6.45	970.3	124.7	4.01
215	15.622	15.604	1.010	12.390	1.616	.65	11.090	10″	1″	2654.7	339.9	6.48	1024.5	131.3	4.03
225	15.764	15.650	1.056	12.390	1.687	.65	11.090	10″	1″	2806.2	356.0	6.51	1079.1	137.9	4.04
235	15.908	15.693	1.099	12.390	1.759	.65	11.090	10″	1″	2961.9	372.4	6.55	1134.5	144.6	4.05
245	16.050	15.738	1.144	12.390	1.830	.65	11.090	10″	1″	3119.6	388.7	6.58	1190.6	151.3	4.06
255	16.192	15.781	1.187	12.390	1.901	.65	11.090	10″	1″	3280.0	405.1	6.61	1247.1	158.0	4.08
265	16.332	15.826	1.232	12.390	1.971	.65	11.090	10″	1″	3442.4	421.6	6.65	1304.2	164.8	4.09

NOTE: For the convenience of the designer beams from 68 lb. to 265 lb. per foot are duplicated on the following page in conjunction with those from **275** lb. to 425 lb. per foot.

† Special Section Web Thickness ⅜″
‡ Special Section for Column core



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration



14″

ALLOWABLE CONCENTRIC LOAD IN KIPS FOR 14″ ROLLED COLUMNS — CARNEGIE SECTIONS

Weight per foot	Area Sq. In.	Least Radius Gyration	UNSUPPORTED LENGTH IN FEET																			
			8	10	12	14	15	16	17	18	19	20	22	24	26	28	30	32	34	36	38	40
14″ CARNEGIE BEAM SECTIONS																						
68	19.99	2.46	300	300	300	286	277	269	260	252	244	235	219	204	190	177	164	153	142			
75	22.05	2.47	331	331	331	316	306	297	288	279	269	260	243	226	210	196	182	169	158			
85	24.99	3.05	375	375	375	375	375	369	360	352	343	335	318	301	284	269	254	239	226			
95	27.93	3.06	419	419	419	419	419	413	403	394	384	375	356	337	319	301	284	268	253			
105	30.88	3.08	463	463	463	463	463	457	447	437	426	416	395	374	354	335	316	298	281			
86	25.28	3.84	379	379	379	379	379	379	379	379	379	374	360	347	333	319	306	293	280	267	255	244
96	28.23	3.86	423	423	423	423	423	423	423	423	423	418	403	388	373	358	343	328	314	300	286	273
106	31.18	3.87	468	468	468	468	468	468	468	468	468	462	446	429	412	396	379	363	347	332	317	303
115	33.82	3.89	507	507	507	507	507	507	507	507	507	502	485	467	448	430	413	395	378	361	345	330
125	36.75	3.90	551	551	551	551	551	551	551	551	551	547	527	508	488	468	449	430	411	393	376	359
‡ 131	38.52	3.77	578	578	578	578	578	578	578	578	576	566	545	524	502	481	460	440	420	401	382	365
135	39.70	3.92	596	596	596	596	596	596	596	596	596	591	570	549	528	507	486	466	446	426	407	389
145	42.64	3.93	640	640	640	640	640	640	640	640	640	636	614	591	568	546	523	502	480	459	439	420
155	45.58	3.94	684	684	684	684	684	684	684	684	684	680	657	633	608	584	560	537	514	492	470	450
165	48.52	3.96	728	728	728	728	728	728	728	728	728	725	700	675	649	624	599	574	549	526	503	481
175	51.47	3.97	772	772	772	772	772	772	772	772	772	770	744	717	690	663	636	610	584	559	535	511
185	54.41	3.98	816	816	816	816	816	816	816	816	816	815	787	759	731	702	674	646	619	593	567	542
195	57.34	4.00	860	860	860	860	860	860	860	860	860	860	831	801	771	741	712	683	654	626	599	573
205	60.28	4.01	904	904	904	904	904	904	904	904	904	904	874	843	812	781	749	719	689	660	631	604
215	63.23	4.03	949	949	949	949	949	949	949	949	949	949	919	886	853	821	788	756	725	694	664	636
225	66.17	4.04	993	993	993	993	993	993	993	993	993	993	963	929	895	860	826	793	760	728	697	668
235	69.11	4.05	1037	1037	1037	1037	1037	1037	1037	1037	1037	1037	1006	971	936	900	864	830	795	762	730	699
245	72.06	4.06	1081	1081	1081	1081	1081	1081	1081	1081	1081	1081	1051	1014	977	940	903	867	832	797	763	731
255	74.99	4.08	1125	1125	1125	1125	1125	1125	1125	1125	1125	1125	1095	1057	1019	980	942	905	868	832	797	763
265	77.93	4.09	1169	1169	1169	1169	1169	1169	1169	1169	1169	1169	1139	1100	1060	1020	981	942	903	866	830	795
275	80.87	4.10	1213	1213	1213	1213	1213	1213	1213	1213	1213	1213	1183	1143	1101	1060	1019	979	939	900	863	826
285	83.82	4.12	1257	1257	1257	1257	1257	1257	1257	1257	1257	1257	1229	1187	1144	1102	1059	1018	977	937	898	860
295	86.76	4.13	1301	1301	1301	1301	1301	1301	1301	1301	1301	1301	1273	1229	1186	1142	1098	1055	1013	971	931	892
305	89.70	4.14	1346	1346	1346	1346	1346	1346	1346	1346	1346	1346	1317	1272	1227	1182	1137	1092	1049	1006	965	924
325	95.58	4.17	1434	1434	1434	1434	1434	1434	1434	1434	1434	1434	1407	1360	1312	1264	1217	1170	1123	1078	1034	991
345	101.47	4.19	1522	1522	1522	1522	1522	1522	1522	1522	1522	1522	1496	1447	1396	1346	1295	1245	1196	1148	1102	1056
365	107.34	4.22	1610	1610	1610	1610	1610	1610	1610	1610	1610	1610	1587	1535	1482	1429	1376	1323	1272	1221	1172	1124
385	113.22	4.24	1698	1698	1698	1698	1698	1698	1698	1698	1698	1698	1677	1622	1567	1511	1455	1400	1346	1293	1241	1190
405	119.12	4.27	1787	1787	1787	1787	1787	1787	1787	1787	1787	1787	1769	1712	1654	1595	1537	1479	1423	1367	1313	1260
425	124.99	4.29	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1859	1799	1739	1678	1617	1557	1497	1439	1382	1327

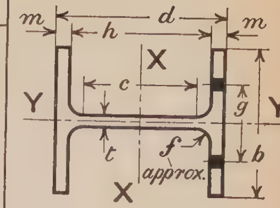
NOTE: For the convenience of the designer beams from 68 lb. to 265 lb. per foot are duplicated on the preceding page in conjunction with those from 30 lb. to 61 lb. per foot. Loads to right of heavy vertical lines are for Secondary Members ONLY. ‡ Special Section for Column Core.

DIMENSIONS AND FUNCTIONS OF 14″ ROLLED COLUMNS — CARNEGIE SECTIONS

Weight per foot	Dimensions d	b	t	h	m	f	c	g	Riv.	Axis X-X I	S	r	Axis Y-Y I	S	r
14″ CARNEGIE BEAM SECTIONS															
68	14.238	10.043	.425	12.810	.714	.55	11.710	5½	1″	738.8	103.8	6.08	120.6	24.0	2.46
75	14.382	10.086	.468	12.810	.786	.55	11.710	5½	1″	823.5	114.5	6.11	134.5	26.7	2.47
85	14.000	12.000	.435	12.390	.805	.65	11.090	9″	1″	921.3	131.6	6.07	232.0	38.7	3.05
95	14.186	12.050	.485	12.390	.898	.65	11.090	9″	1″	1044.0	147.2	6.11	262.0	43.5	3.06
105	14.370	12.101	.536	12.390	.990	.65	11.090	9″	1″	1169.6	162.8	6.15	292.6	48.4	3.08
86	13.714	15.008	.414	12.390	.662	.65	11.090	10″	1″	923.0	136.6	6.04	373.1	49.7	3.84
96	13.866	15.056	.462	12.390	.738	.65	11.090	10″	1″	1042.1	150.3	6.08	419.9	55.8	3.86
106	14.018	15.103	.509	12.390	.814	.65	11.090	10″	1″	1164.1	166.1	6.11	467.6	61.9	3.87
115	14.154	15.145	.551	12.390	.882	.65	11.090	10″	1″	1275.9	180.3	6.14	510.9	67.5	3.89
125	14.304	15.191	.597	12.390	.957	.65	11.090	10″	1″	1402.1	196.0	6.18	559.4	73.7	3.90
‡131	14.162	15.468	.874	12.390	.886	.65	11.090	10″	1″	1358.4	191.8	5.94	547.3	70.8	3.77
135	14.452	15.239	.645	12.390	1.031	.65	11.090	10″	1″	1530.4	211.8	6.21	608.4	79.9	3.92
145	14.602	15.284	.690	12.390	1.106	.65	11.090	10″	1″	1662.7	227.7	6.24	658.5	86.2	3.93
155	14.750	15.330	.736	12.390	1.180	.65	11.090	10″	1″	1796.8	243.6	6.28	709.0	92.5	3.94
165	14.896	15.377	.783	12.390	1.253	.65	11.090	10″	1″	1932.6	259.5	6.31	759.9	98.8	3.96
175	15.042	15.424	.830	12.390	1.326	.65	11.090	10″	1″	2071.7	275.5	6.34	811.6	105.2	3.97
185	15.188	15.469	.875	12.390	1.399	.65	11.090	10″	1″	2213.5	291.5	6.38	863.9	111.7	3.98
195	15.334	15.513	.919	12.390	1.472	.65	11.090	10″	1″	2358.2	307.6	6.41	916.8	118.2	4.00
205	15.478	15.559	.965	12.390	1.544	.65	11.090	10″	1″	2505.0	323.7	6.45	970.3	124.7	4.01
215	15.622	15.604	1.010	12.390	1.616	.65	11.090	10″	1″	2654.7	339.9	6.48	1024.5	131.3	4.03
225	15.764	15.650	1.056	12.390	1.687	.65	11.090	10″	1″	2806.2	356.0	6.51	1079.1	137.9	4.04
235	15.908	15.693	1.099	12.390	1.759	.65	11.090	10″	1″	2961.9	372.4	6.55	1134.5	144.6	4.05
245	16.050	15.738	1.144	12.390	1.830	.65	11.090	10″	1″	3119.6	388.7	6.58	1190.6	151.3	4.06
255	16.192	15.781	1.187	12.390	1.901	.65	11.090	10″	1″	3280.0	405.1	6.61	1247.1	158.0	4.08
265	16.332	15.826	1.232	12.390	1.971	.65	11.090	10″	1″	3442.4	421.6	6.65	1304.2	164.8	4.09
275	16.472	15.870	1.276	12.390	2.041	.65	11.090	10″	1″	3607.8	438.1	6.68	1362.0	171.6	4.10
285	16.614	15.912	1.318	12.390	2.112	.65	11.090	10″	1″	3778.1	454.8	6.71	1420.7	178.6	4.12
295	16.752	15.956	1.362	12.390	2.181	.65	11.090	10″	1″	3948.1	471.4	6.75	1479.4	185.4	4.13
305	16.890	16.000	1.406	12.390	2.250	.65	11.090	10″	1″	4121.5	488.0	6.78	1539.1	192.4	4.14
325	17.164	16.087	1.493	12.390	2.387	.65	11.090	10″	1″	4475.9	521.6	6.84	1659.9	206.4	4.17
345	17.438	16.172	1.578	12.390	2.524	.65	11.090	10″	1″	4843.4	555.5	6.91	1783.5	220.6	4.19
365	17.710	16.255	1.661	12.390	2.660	.65	11.090	10″	1″	5221.4	589.7	6.97	1909.1	234.9	4.22
385	17.978	16.340	1.746	12.390	2.794	.65	11.090	10″	1″	5609.4	624.0	7.04	2037.4	249.4	4.24
405	18.246	16.423	1.829	12.390	2.928	.65	11.090	10″	1″	6010.5	658.8	7.10	2168.2	264.0	4.27
425	18.510	16.506	1.912	12.390	3.060	.65	11.090	10″	1″	6420.5	693.7	7.17	2301.0	278.8	4.29

NOTE: For the convenience of the designer beams from 68 lb. to 265 lb. per foot are duplicated on the preceding page in conjunction with those from 30 lb. to 61 lb. per foot.

‡ Special Section for Column core



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

14″

NOTES and DIAGRAMS

Part IV

Section 12

Plate and Angle Columns

Plate and Angle Columns with Cover Plates

Channel and Plate Columns

Dimensions

Technical Functions

Allowable Concentric Loads

by

A. I. S. C. Specification

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 8½" PLATE AND ANGLE COLUMNS

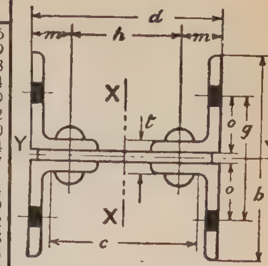
1 Web Plate	4 Angles	Weight Per Foot	Area Sq. in.	Least Radius Gyr.	UNSUPPORTED LENGTH IN FEET															
					4	8	10	11	12	13	14	15	16	17	18	20	22	24	26	30
8×1/4	2½×2½×1/4	23.2	6.76	.96	101	78	65	59	54	49	45	41	38	...	...	...	...	...	...	...
	3×2½×1/4	24.8	7.24	1.19	109	96	83	77	72	66	62	57	53	...	...	...	...	...	...	...
	5/16	29.2	8.48	1.23	127	114	100	93	87	81	75	70	65	...	...	...	...	...	...	...
	3½×2½×1/4	26.4	7.76	1.44	116	112	101	95	90	85	80	75	70	66	62	55	49	...	...	...
	5/16	31.2	9.12	1.49	137	133	120	114	108	102	96	90	85	80	76	67	60	...	...	...
	3/8	35.6	10.44	1.52	157	154	140	132	125	118	112	106	100	94	89	79	70	...	...	...
	3½×3×1/4	28.4	8.24	1.40	124	118	105	99	93	87	82	77	73	68	64	56	50	...	...	...
	5/16	33.2	9.72	1.44	146	140	126	119	112	106	100	94	88	83	78	69	61	...	...	...
	3/8	38.4	11.20	1.47	168	163	147	139	131	124	117	110	103	97	92	81	72	...	...	...
	4×3×1/4	30.0	8.76	1.64	131	131	122	116	110	105	100	95	90	85	80	72	65	...	...	...
	5/16	35.6	10.36	1.69	155	155	146	139	133	127	120	113	109	103	98	88	79	...	...	...
	3/8	40.8	11.92	1.72	179	179	169	162	154	147	140	133	127	120	114	103	93	...	...	...
	4×3½×3/8	43.2	12.68	1.68	190	190	178	170	162	154	147	139	132	125	119	107	96	...	...	...
	5×3½×5/16	41.6	12.24	2.15	184	184	184	182	176	171	165	159	153	147	141	130	120	...	...	...
	3/8	48.4	14.20	2.19	213	213	213	213	206	199	193	186	179	172	166	153	141	...	...	...
8×5/16	2½×2½×5/16	28.5	8.38	.98	126	98	82	75	69	63	57	52	48	...	...	...	...	...	...	...
	3×2½×5/16	30.9	8.98	1.22	135	120	105	98	91	85	79	73	68	...	...	...	...	...	...	...
	3/8	34.9	10.18	1.26	153	139	122	114	106	99	92	86	80	...	...	...	...	...	...	...
	3½×2½×5/16	32.9	9.62	1.47	144	140	126	119	113	106	100	94	89	84	79	70	62	...	...	...
	3/8	37.3	10.94	1.51	164	161	146	138	131	124	117	110	104	98	92	82	73	...	...	...
	3½×3×5/16	34.9	10.22	1.42	153	147	132	124	117	110	103	97	91	85	80	71	63	...	...	...
	3/8	40.1	11.70	1.46	176	170	153	144	137	129	121	114	107	101	95	84	75	...	...	...
	4×3×5/16	37.3	10.86	1.67	163	163	152	145	138	132	125	119	113	107	101	91	82	...	...	...
	3/8	42.5	12.42	1.71	186	186	175	168	160	153	145	138	132	125	118	107	96	...	...	...
	4×3½×3/8	44.9	13.18	1.67	198	198	184	176	168	160	152	144	137	130	123	110	99	...	...	...
	5×3½×5/16	43.3	12.74	2.13	191	191	191	189	183	177	170	164	158	152	146	135	124	114	105	89
	3/8	50.1	14.70	2.17	221	221	221	219	213	206	198	191	184	177	171	158	145	134	123	105
8×3/8	3×2½×3/8	36.6	10.68	1.25	160	145	127	119	111	103	96	89	83	77	72	...	...	...	...	...
	3×3×3/8	39.0	11.44	1.21	172	152	133	124	115	107	99	92	86	80	74	...	...	...	...	...
	3½×2½×3/8	39.0	11.44	1.50	172	168	152	144	136	128	121	114	108	102	96	...	...	...	...	...
	3½×3×3/8	41.8	12.20	1.45	183	177	159	150	142	134	126	118	111	104	98	...	...	...	...	...
	7/16	46.6	13.60	1.49	204	199	180	170	161	152	143	135	127	120	113	100	89	...	...	...
	4×3×3/8	44.2	12.92	1.70	194	194	182	174	166	158	151	143	136	129	123	110	99	...	...	...
	7/16	49.4	14.48	1.73	217	217	206	197	188	180	171	163	155	147	140	126	114	...	...	...
	4×3½×3/8	46.6	13.68	1.66	205	205	191	182	174	165	157	149	141	134	127	114	102	...	...	...
	5×3½×3/8	51.8	15.20	2.15	228	228	228	226	219	212	204	197	190	182	175	162	149	137	126	107
	7/16	58.2	17.12	2.19	257	257	257	256	248	240	232	224	216	208	200	185	171	157	145	123

Unequal Angles have short leg against web plate.
Weights given do not include rivets or other details.
Loads to right of heavy verticallines are for Secondary Members ONLY.

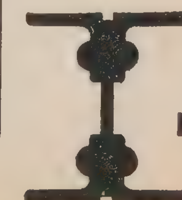
LOADS BY A. I. S. C. SPECIFICATION

DIMENSIONS AND FUNCTIONS OF 8½″ PLATE AND ANGLE COLUMNS

1 Web Plate	4 Angles	DIMENSIONS d	b	t	h	m	o	g	c	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
8×¼	2½×2½×¼	8½	5¼	¾	5¾	1⅜	1⅜	3	7½	¾	73	17.1	3.28	6.2	2.4	.96
	3 ×2½×¼	"	6¼	¾	"	"	1¾	3¾	7⅜	"	82	19.2	3.35	10.3	3.3	1.19
	5/16	"	6¼	⅞	"	"	"	"	7¼	"	97	22.8	3.38	12.9	4.1	1.23
	3½×2½×¼	"	7¼	¾	"	"	2	4¼	7⅜	"	90	21.1	3.40	16.0	4.4	1.44
	5/16	"	"	⅞	"	"	"	"	7¼	"	108	25.4	3.43	20.2	5.6	1.49
	⅜	"	"	1	"	"	"	"	7⅛	"	124	29.1	3.44	24.2	6.7	1.52
	3½×3 ×¼	"	"	¾	5	1¾	"	"	7¼	⅞	91	21.3	3.31	16.1	4.4	1.40
	5/16	"	"	⅞	"	"	"	"	7⅛	"	108	25.5	3.34	20.2	5.6	1.44
	⅜	"	"	1	"	"	"	"	7	"	126	29.6	3.35	24.3	6.7	1.47
	4 ×3 ×¼	8½	8¼	¾	5	1¾	2½	5¼	7¼	⅞	100	23.5	3.38	23.7	5.8	1.64
	5/16	"	"	⅞	"	"	"	"	7⅛	"	119	28.0	3.38	29.6	7.2	1.69
	⅜	"	"	1	"	"	"	"	7	"	138	32.4	3.40	35.4	8.6	1.72
	4 ×3½×⅜	"	"	1	4½	2	"	"	7	"	138	32.6	3.30	35.8	8.7	1.68
	5 ×3½×5/16	"	10¼	⅞	"	"	3	6¼	7	"	141	33.1	3.39	56.5	11.0	2.15
	⅜	"	"	1	"	"	"	"	6⅞	"	164	38.6	3.40	67.8	13.2	2.19
8×5/16	2½×2½×5/16	8½	5 5/16	15/16	5¾	1⅜	1⅜	3 1/16	7⅜	¾	89	21.0	3.26	8.1	3.1	.98
	3 ×2½×5/16	"	6 5/16	15/16	"	"	1¾	3 13/16	7¼	"	99	23.4	3.33	13.3	4.2	1.22
	⅜	"	6 5/16	1 1/16	"	"	"	"	7⅛	"	113	26.7	3.34	16.2	5.1	1.26
	3½×2½×5/16	"	7 5/16	15/16	"	"	2	4 5/16	7¼	"	110	25.9	3.38	20.7	5.6	1.47
	⅜	"	"	1 1/16	"	"	"	"	7⅛	"	126	29.7	3.40	24.9	6.8	1.51
	3½×3 ×5/16	"	"	15/16	5	1¾	"	"	7⅛	⅞	111	26.1	3.30	20.7	5.7	1.42
	⅜	"	"	1 1/16	"	"	"	"	7	"	128	30.1	3.31	25.0	6.8	1.46
	4 ×3 ×5/16	8½	8 5/16	15/16	5	1¾	2½	5 5/16	7⅛	⅞	121	28.6	3.34	30.3	7.3	1.67
	⅜	"	"	1 1/16	"	"	"	"	7	"	140	33.0	3.36	36.3	8.7	1.71
	4 ×3½×⅜	"	"	1 1/16	4½	2	"	"	7	"	141	33.2	3.27	36.7	8.8	1.67
	5 ×3½×5/16	"	10 5/16	15/16	"	"	3	6 5/16	7	"	143	33.7	3.35	57.6	11.2	2.13
	⅜	"	"	1 1/16	"	"	"	"	6⅞	"	167	39.2	3.37	69.2	13.4	2.17
8×⅜	3 ×2½×⅜	8½	6⅜	1⅛	5¾	1⅜	1¾	3⅞	7⅛	¾	116	27.3	3.29	16.8	5.3	1.25
	3 ×3 ×⅜	"	6⅜	"	5	1¾	"	"	7⅛	⅞	118	27.8	3.21	16.8	5.3	1.21
	3½×2½×⅜	"	7⅜	"	5¾	1⅜	2	4⅜	7⅛	¾	129	30.4	3.36	25.6	6.9	1.50
	3½×3 ×⅜	"	"	"	5	1¾	"	"	7	⅞	131	30.8	3.26	25.7	7.0	1.45
	7/16	"	"	1¼	"	"	"	"	6⅞	"	147	34.5	3.29	30.0	8.1	1.49
	4 ×3 ×⅜	8½	8⅜	1⅛	5	1¾	2½	5⅜	7	⅞	143	33.7	3.33	37.2	8.9	1.70
	7/16	"	"	1¼	"	"	"	"	6⅞	"	161	37.9	3.34	43.5	10.4	1.73
	4 ×3½×⅜	"	"	1⅛	4½	2	"	"	7	"	144	33.8	3.24	37.7	9.0	1.66
	5 ×3½×⅜	"	10⅜	1⅛	"	"	3	6⅜	7	"	169	39.8	3.33	70.5	13.6	2.15
	7/16	"	"	1¼	"	"	"	"	6⅞	"	191	45.0	3.34	82.2	15.8	2.19



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration



8½″

Unequal Angles have short leg against web plate.
Dimensions *h*, *m*, *o* and *g* can be varied considerably.

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 10½″ PLATE AND ANGLE COLUMNS

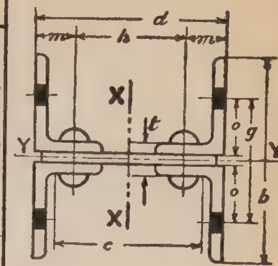
1 Web Plate	4 Angles	Weight Per Foot	Area Sq. in.	Least Radius Gyr.	UNSUPPORTED LENGTH IN FEET															
					6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	32
10×¼	3½ × 2½ × ¼	28.1	8.26	1.39	124	123	118	111	105	93	82	72	63	56	...	...	...	...	...	...
	5/16	32.9	9.62	1.45	144	144	139	132	125	112	99	88	78	69	...	...	...	...	...	...
	3/8	37.3	10.94	1.49	164	164	160	153	145	130	115	102	91	81	...	...	...	...	...	...
	3½ × 3 × ¼	30.1	8.74	1.36	131	130	123	117	110	97	85	75	66	58	...	...	...	...	...	...
	5/16	34.9	10.22	1.41	153	153	146	139	131	117	103	91	80	71	...	...	...	...	...	...
	3/8	40.1	11.70	1.44	176	176	169	161	152	135	120	106	94	83	...	...	...	...	...	...
	4 × 3 × ¼	31.7	9.26	1.60	139	139	139	133	127	115	103	93	83	74	66	...	...	...	...	...
	5/16	37.3	10.86	1.65	163	163	163	158	151	137	124	112	100	90	81	...	...	...	...	...
	3/8	42.5	12.42	1.69	186	186	186	182	175	159	144	130	117	105	95	...	...	...	...	...
	4 × 3½ × 3/8	44.9	13.18	1.65	198	198	198	192	184	167	151	135	122	109	98	...	...	...	...	...
	5 × 3½ × 5/16	43.3	12.74	2.11	191	191	191	191	191	182	170	157	145	133	123	113	104	96	88	...
	3/8	50.1	14.70	2.15	221	221	221	221	221	212	198	183	170	156	144	133	122	112	103	...
10×5/16	3½ × 2½ × 5/16	35.0	10.25	1.42	154	154	147	140	132	117	104	92	81	71	63	...	...	...	...	...
	3/8	39.4	11.57	1.47	174	174	168	160	152	136	121	107	95	84	75	...	...	...	...	...
	3½ × 3 × 5/16	37.0	10.85	1.38	163	162	154	146	138	122	107	94	83	73	64	...	...	...	...	...
	3/8	42.2	12.33	1.42	185	185	177	168	159	141	125	110	97	86	76	...	...	...	...	...
	4 × 3 × 5/16	39.4	11.49	1.62	172	172	172	166	159	144	129	116	104	93	84	...	...	...	...	...
	3/8	44.6	13.05	1.67	196	196	196	191	183	166	150	135	122	109	98	...	...	...	...	...
	4 × 3½ × 3/8	47.0	13.81	1.63	207	207	207	200	191	173	156	140	126	113	101	...	...	...	...	...
	5 × 3½ × 5/16	45.4	13.37	2.08	201	201	201	201	201	190	177	163	151	138	127	117	107	98	90	...
	3/8	52.2	15.33	2.12	230	230	230	230	230	220	205	190	175	161	148	136	125	116	106	...
10×3/8	3½ × 3 × 3/8	44.4	12.95	1.41	194	194	185	176	166	148	130	115	101	89	79	...	...	...	...	...
	4 × 3 × 3/8	46.8	13.67	1.65	205	205	205	199	190	173	156	140	126	113	102	...	...	...	...	...
	4 × 3½ × 3/8	49.2	14.43	1.62	217	217	217	208	199	181	163	146	131	117	105	...	...	...	...	...
	5 × 3½ × 3/8	54.4	15.95	2.10	239	239	239	239	239	228	212	196	181	166	153	140	129	118	109	...
	7/16	60.8	17.87	2.14	268	268	268	268	268	257	240	222	206	189	174	160	147	136	125	...
	½	67.2	19.75	2.19	296	296	296	296	296	287	268	249	231	213	197	181	167	154	142	...
	6 × 4 × 3/8	62.0	18.19	2.56	273	273	273	273	273	273	264	249	235	220	206	192	179	167	156	...
	7/16	70.0	20.47	2.61	307	307	307	307	307	307	299	283	267	251	235	220	205	192	179	167
	½	77.6	22.75	2.65	341	341	341	341	341	341	335	317	299	281	264	247	231	216	202	189
10×½	6 × 4 × ½	81.8	24.00	2.62	360	360	360	360	360	360	352	333	314	295	276	258	242	226	211	197
	9/16	89.4	26.24	2.66	394	394	394	394	394	394	387	366	346	325	305	286	268	251	234	219
	5/8	97.0	28.44	2.69	427	427	427	427	427	427	421	399	377	355	333	313	293	274	257	241
10×5/8	6 × 4 × 5/8	101.3	29.69	2.68	445	445	445	445	445	445	438	416	393	370	347	325	305	285	267	250
	¾	115.7	34.01	2.75	510	510	510	510	510	510	507	482	456	430	405	380	357	335	314	294
10×¾	6 × 4 × ¾	119.9	35.26	2.74	529	529	529	529	529	529	525	499	472	445	419	393	369	346	324	303
	7/8	134.3	39.42	2.80	591	591	591	591	591	591	591	563	533	504	475	447	420	394	370	347

Unequal Angles have short leg against web plate.
Weights given do not include rivets or other details.
Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 10½″ PLATE AND ANGLE COLUMNS

1 Web Plate	4 Angles	DIMENSIONS d	b	t	h	m	o	g	c	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
10×¼	3½×2½×¼	10½	7¼	¾	7¾	1⅜	2	4 ¼	9⅜	¾	148	28.2	4.23	16.0	4.4	1.39
	5/16	"	"	⅞	"	"	"	"	9¼	"	176	33.5	4.28	20.2	5.6	1.45
	3/8	"	"	1	"	"	"	"	9⅛	"	203	38.6	4.30	24.2	6.7	1.49
	3½×3 ×¼	"	"	¾	7	1¾	"	"	9¼	⅞	150	28.6	4.15	16.1	4.4	1.36
	5/16	"	"	⅞	"	"	"	"	9⅛	"	179	34.2	4.19	20.2	5.6	1.41
	3/8	"	"	1	"	"	"	"	9	"	208	39.6	4.21	24.3	6.7	1.44
	4 ×3 ×¼	10½	8¼	¾	7	1¾	2½	5 ¼	9¼	⅞	164	31.2	4.20	23.7	5.8	1.60
	5/16	"	"	⅞	"	"	"	"	9⅛	"	196	37.3	4.24	29.6	7.2	1.65
	3/8	"	"	1	"	"	"	"	9	"	227	43.2	4.27	35.4	8.6	1.69
	4 ×3½×⅜	"	"	1	6½	2	"	"	9	"	229	43.7	4.17	35.8	8.7	1.65
	5 ×3½×5/16	"	10¼	⅞	"	"	3	6 ¼	9	"	231	44.0	4.26	56.5	11.0	2.11
	3/8	"	"	1	"	"	"	"	8⅞	"	269	51.0	4.27	67 8	13.3	2.15
10×5/16	3½×2½×5/16	10½	7 5/16	15/16	7¾	1⅜	2	4 5/16	9¼	¾	181	34.5	4.20	20.7	5.7	1.42
	3/8	"	"	1 1/16	"	"	"	"	9⅛	"	208	39.6	4.24	24.9	6.8	1.47
	3½×3 ×5/16	"	"	15/16	7	1¾	"	"	9⅛	⅞	185	35.2	4.13	20.7	5.7	1.38
	3/8	"	"	1 1/16	"	"	"	"	9	"	213	40.4	4.15	25.0	6.8	1.42
	4 ×3 ×5/16	10½	8 5/16	15/16	7	1¾	2½	5 5/16	9⅛	⅞	201	38.3	4.18	30.3	7.3	1.62
	3/8	"	"	1 1/16	"	"	"	"	9	"	232	44.2	4.22	36.3	8.7	1.67
	4 ×3½×⅜	"	"	"	6½	2	"	"	9	"	235	44.7	4.19	36.7	8.9	1.63
	5 ×3½×5/16	"	10 5/16	15/16	"	"	3	6 5/16	9	"	236	45.0	4.20	57.6	11.2	2.08
	3/8	"	"	1 1/16	"	"	"	"	8⅞	"	274	52.2	4.23	69 2	13.4	2.12
10×⅜	3½×3 ×⅜	10½	7⅜	1⅛	7	1¾	2	4 ⅜	9	⅞	218	41.6	4.11	25.7	7.0	1.41
	4 ×3 ×⅜	"	8⅜	"	"	"	2½	5 ⅜	9	"	237	45.2	4.17	37.2	8 9	1.65
	4 ×3½×⅜	"	"	"	6½	2	"	"	9	"	240	45.7	4.08	37.7	9.0	1.62
	5 ×3½×⅜	10½	10⅜	1⅛	6½	2	3	6 ⅜	8⅞	⅞	279	53.2	4.18	70.5	13.6	2.10
	7/16	"	"	1¼	"	"	"	"	8¾	"	315	60.0	4.20	82.2	15.8	2.14
	½	"	"	1⅜	"	"	"	"	8⅝	"	349	66.6	4.21	94.6	18.2	2.19
	6 ×4 ×⅜	"	12⅜	1⅛	5½	2½	3½	7 ⅜	8¾	"	319	60.8	4.19	119.2	19.3	2 56
	7/16	"	"	1¼	"	"	"	"	8⅝	⅞	361	68.8	4.20	139.0	22.5	2.61
	½	"	"	1⅜	"	"	"	"	8½	"	401	76.4	4 20	159.7	25.8	2.65
10×½	6 ×4 ×½	10½	12½	1½	5½	2½	3½	7 ½	8½	⅞	412	78.5	4.14	164.9	26.3	2.62
	9/16	"	"	1⅝	"	"	"	"	8⅜	"	451	85.9	4.15	185.5	29.7	2.66
	⅝	"	"	1¾	"	"	"	"	8¼	"	490	93.3	4.15	206.1	33.0	2.69
10×⅝	6 ×4 ×⅝	10½	12⅝	1⅞	5½	2½	3½	7 ⅝	8¼	⅞	500	95.3	4.10	212.9	33.7	2.68
	¾	"	"	2⅛	"	"	"	"	8	"	569	108.4	4.09	256.9	40.7	2.75
10×¾	6 ×4 ×¾	10½	12¾	2¼	5½	2½	3½	7 ¾	8	⅞	580	110.3	4.05	265.4	41.6	2.74
	⅞	"	"	2½	"	"	"	"	7¾	"	646	123.0	4.05	309 6	48.6	2.80

Unequal angles have short leg against web plate.
Dimensions *h*, *m*, *o* and *g* can be varied considerably.



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

10½″

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 12½″ PLATE AND ANGLE COLUMNS

[For 12½″ Columns with Cover Plates see following pages]

1 Web Plate	Angles	Weight Per Foot	Area Sq. in.	Least Radius Gyr.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
12×¼	3½×2½×¼	29.8	8.76	1.36	131	124	110	97	86	75	66	58	51	...	...	...	...	...	...	...
	⅜	39.0	11.44	1.45	172	165	149	133	118	104	92	82	73	...	...	...	...	...	...	...
	3½×3 ×¼	31.8	9.24	1.32	139	129	114	100	88	76	67	59	52	...	...	...	...	...	...	...
	⅜	41.8	12.20	1.41	183	175	157	139	123	108	95	84	74	...	...	...	...	...	...	...
	4 ×3 ×¼	33.4	9.76	1.56	146	145	132	119	107	95	85	76	68	...	...	...	...	...	...	...
	⅜	44.2	12.92	1.66	194	194	180	164	148	133	120	108	97	...	...	...	...	...	...	...
	4 ×3½×⅜	46.6	13.68	1.62	205	205	189	171	154	138	124	111	100	...	...	...	...	...	...	...
	5 ×3½×5⁄16	45.0	13.24	2.07	199	199	199	188	175	161	149	137	125	115	105	96	89	...	...	...
	⅜	51.8	15.20	2.11	228	228	228	217	202	187	173	159	146	134	124	114	105	...	...	...
12×5⁄16	3½×2½×5⁄16	37.2	10.87	1.38	163	154	138	122	107	94	83	73	64	...	...	...	...	...	...	...
	⅜	41.6	12.19	1.43	183	176	158	140	124	110	97	86	76	...	...	...	...	...	...	...
	3½×3 ×5⁄16	39.2	11.47	1.34	172	161	143	126	110	96	84	74	65	...	...	...	...	...	...	...
	⅜	44.4	12.95	1.39	194	184	165	146	129	113	99	88	78	...	...	...	...	...	...	...
	4 ×3 ×5⁄16	41.6	12.11	1.58	182	181	165	149	134	120	107	96	85	...	...	...	...	...	...	...
	⅜	46.8	13.67	1.63	205	205	189	172	155	139	125	112	100	...	...	...	...	...	...	...
	4 ×3½×⅜	49.2	14.43	1.59	217	216	197	178	160	143	128	115	102	...	...	...	...	...	...	...
	5 ×3½×5⁄16	47.6	13.99	2.03	210	210	210	197	182	168	155	142	130	119	109	100	92	...	...	...
	⅜	54.4	15.95	2.08	239	239	239	227	211	195	180	165	152	139	128	118	108	...	...	...
12×⅜	4 ×3 ×⅜	49.3	14.42	1.61	216	216	198	180	162	145	130	116	104	...	...	...	...	...	...	...
	4 ×3½×⅜	51.7	15.18	1.57	228	226	206	186	167	149	133	119	106	...	...	...	...	...	...	...
	5 ×3½×⅜	56.9	16.70	2.05	251	251	251	236	219	202	186	171	156	143	131	120	111	...	...	...
	7⁄16	63.3	18.62	2.10	279	279	279	266	247	229	211	194	178	164	150	138	127	...	...	...
	½	69.7	20.50	2.15	308	308	308	295	275	256	237	218	201	185	170	156	144	...	...	...
	6 ×4 ×⅜	64.5	18.94	2.51	284	284	284	284	273	257	241	226	211	197	184	171	159	148	138	129
	7⁄16	72.5	21.22	2.56	318	318	318	318	309	291	274	257	240	224	209	195	182	170	158	148
	½	80.1	23.50	2.61	353	353	353	353	344	325	306	288	270	252	236	220	206	192	179	168
12×½	5 ×3½×½	74.8	22.00	2.11	330	330	330	315	293	271	250	230	212	194	179	164	151	...	...	...
	⅝	87.6	25.68	2.19	385	385	385	372	348	324	300	277	256	236	217	200	185	...	...	...
	6 ×4 ×½	85.2	25.00	2.57	375	375	375	375	364	344	323	303	284	265	248	231	215	201	188	175
	9⁄16	92.8	27.24	2.61	409	409	409	409	399	377	355	334	313	293	273	255	238	223	208	194
	⅝	100.4	29.44	2.65	442	442	442	442	433	410	387	364	342	320	300	280	261	245	229	214
12×⅝	6 ×4 ×⅝	105.5	30.94	2.62	464	464	464	464	453	429	404	380	356	333	312	291	272	254	237	222
	¾	119.9	35.26	2.70	529	529	529	529	522	495	468	441	415	389	364	341	319	299	280	262
12×¾	6 ×4 ×¾	125.0	36.76	2.69	551	551	551	551	544	516	487	459	431	404	379	354	332	310	290	272
	⅞	139.4	40.92	2.75	614	614	614	614	611	579	549	518	487	457	430	403	377	353	331	311
	6 ×6 ×¾	145.4	42.76	2.51	641	641	641	641	616	581	545	510	477	445	414	386	359	335	312	291
	⅞	163.0	47.92	2.57	719	719	719	719	697	658	620	581	544	508	474	443	413	385	360	335

Columns 6 to 36: Unsupported Length in Feet.

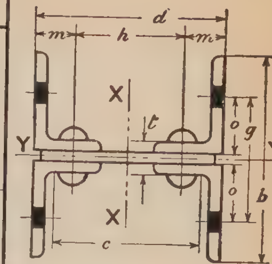
Unequal Angles have short leg against web plate.
Weights given do not include rivets or other details.
Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 12½″ PLATE AND ANGLE COLUMNS

[For 12½″ Columns with Cover Plates see following pages]

1 Web Plate	4 Angles	DIMENSIONS d	b	t	h	m	o	g	c	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
12×¼	3½×2½×¼	12½	7¼	¾	9¾	1⅜	2	4¼	11⅜	¾	222	36	5.04	16.0	4.4	1.36
	⅜	"	"	1	"	"	"	"	11⅛	"	304	49	5.15	24.2	6.7	1.45
	3½×3 ×¼	"	"	¾	9	1¾	"	"	11¼	⅞	227	36	4.96	16.1	4.4	1.32
	⅜	"	"	1	"	"	"	"	11	"	313	50	5.07	24.3	6.7	1.41
	4 ×3 ×¼	12½	8¼	¾	9	1¾	2½	5¼	11¼	⅞	247	40	5.03	23.7	5.8	1.56
	⅜	"	"	1	"	"	"	"	11	"	341	55	5.14	35.4	8.6	1.66
	4 ×3½×⅜	"	"	1	8½	2	"	"	11	"	347	56	5.03	35.8	8.7	1.62
	5 ×3½×5/16	"	10¼	⅞	"	"	3	6¼	11	"	347	56	5.12	56.5	11.0	2.07
	⅜	"	"	1	"	"	"	"	10⅞	"	403	65	5.15	67.8	13.3	2.11
12×5/16	3½×2½×5/16	12½	7 5/16	15/16	9¾	1⅜	2	4 5/16	11¼	¾	273	44	5.01	20.7	5.7	1.38
	⅜	"	"	1 1/16	"	"	"	"	11⅛	"	313	50	5.07	24.9	6.8	1.43
	3½×3 ×5/16	"	"	15/16	9	1¾	"	"	11⅛	⅞	280	45	4.94	20.7	5.7	1.34
	⅜	"	"	1 1/16	"	"	"	"	11	"	323	52	4.91	25.0	6.8	1.39
	4 ×3 ×5/16	12½	8 5/16	15/16	9	1¾	2½	5 5/16	11⅛	⅞	304	49	5.01	30.3	7.3	1.58
	⅜	"	"	1 1/16	"	"	"	"	11	"	350	56	5.06	36.3	8.7	1.63
	4 ×3½×⅜	"	"	"	8½	2	"	"	11	"	356	57	4.96	36.7	8.9	1.59
	5 ×3½×5/16	"	10 5/16	15/16	"	"	3	6 5/16	11	"	356	57	5.04	57.6	11.2	2.03
	⅜	"	"	1 1/16	"	"	"	"	10⅞	"	412	66	5.08	69.2	13.4	2.08
12×⅜	4 ×3 ×⅜	12½	8⅜	1⅛	9	1¾	2½	5⅜	11	⅞	359	58	4.99	37.2	8.9	1.61
	4 ×3½×⅜	"	"	"	8½	2	"	"	11	"	365	58	4.90	37.7	9.0	1.57
	5 ×3½×⅜	"	10⅜	"	"	"	3	6⅜	10⅞	"	421	67	5.02	70.5	13.6	2.05
	7/16	"	"	1¼	"	"	"	"	10¾	"	476	76	5.05	82.2	15.8	2.10
	½	"	"	1⅜	"	"	"	"	10⅝	"	526	84	5.07	94.6	18.2	2.15
	6 ×4 ×⅜	12½	12⅜	1⅛	7½	2½	3½	7⅜	10¾	⅞	481	77	5.04	119.2	19.3	2.51
	7/16	"	"	1¼	"	"	"	"	10⅝	"	544	87	5.06	139.0	22.5	2.56
	½	"	"	1⅜	"	"	"	"	10½	"	605	97	5.07	159.7	25.8	2.61
12×½	5 ×3½×½	12½	10½	1½	8½	2	3	6½	10⅝	⅞	544	87	4.97	98.3	18.7	2.11
	⅝	"	"	1¾	"	"	"	"	10⅜	"	643	103	5.01	123.0	23.9	2.19
	6 ×4 ×½	"	12½	1½	7½	2½	3½	7½	10½	"	623	100	4.99	164.9	26.4	2.57
	9/16	"	"	1⅝	"	"	"	"	10⅜	"	683	109	5.01	185.5	29.7	2.61
	⅝	"	"	1¾	"	"	"	"	10¼	"	741	119	5.02	206.1	33.0	2.65
12×⅝	6 ×4 ×⅝	12½	12⅝	1⅞	7½	2½	3½	7⅝	10¼	⅞	759	122	4.95	212.9	33.7	2.62
	¾	"	"	2⅛	"	"	"	"	10	"	867	139	4.96	256.9	40.7	2.70
12×¾	6 ×4 ×¾	12½	12¾	2¼	7½	2½	3½	7¾	10	⅞	885	142	4.91	265.4	41.7	2.69
	⅞	"	"	2½	"	"	"	"	9¾	"	987	158	4.91	309.6	48.6	2.75
	6 ×6 ×¾	"	"	2¼	5½	3½	"	"	10	"	895	143	4.57	269.4	42.3	2.51
	⅞	"	"	2½	"	"	"	"	9¾	"	999	160	4.57	315.2	49.5	2.57

Unequal Angles have short leg against web plate.
Dimensions *h*, *m*, *o* and *g* can be varied considerably.



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

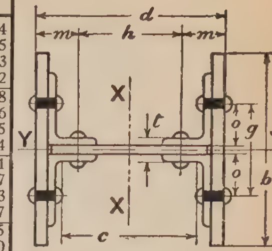
ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 12½″ PLATE AND ANGLE COLUMNS WITH COVER PLATES

1 Web Plate	4 Angles	2 Cover Plates	Weight Per Foot	Area Sq. in.	Least Radius Gyr.	Unsupported Length in Feet: 12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	44
12×3/8	6×4×3/8	14×3/8	100.2	29.44	3.14	442	442	439	420	400	380	361	342	324	306	289	273	258	244	...	...
	3/8	1/2	112.1	32.94	3.25	494	494	494	476	455	434	413	392	372	352	334	316	299	283	...	...
	7/16	1/2	120.1	35.22	3.23	528	528	528	508	485	462	440	418	396	375	355	336	318	301	...	...
	1/2	1/2	127.7	37.50	3.22	563	563	563	540	516	491	467	444	421	398	377	357	338	319	...	...
12×1/2	6×4×1/2	14×1/2	132.8	39.00	3.18	585	585	584	559	533	508	482	457	433	410	388	367	347	328	...	...
	1/2	5/8	144.7	42.50	3.26	638	638	638	615	588	561	534	507	481	456	432	409	387	366	...	...
	9/16	5/8	152.3	44.74	3.25	671	671	671	646	618	589	561	532	505	479	453	429	406	385	...	...
	5/8	5/8	159.9	46.94	3.24	704	704	704	678	647	617	587	558	529	501	474	449	425	402	...	...
12×5/8	6×4×5/8	14×5/8	165.0	48.44	3.21	727	727	727	697	665	634	602	572	542	513	485	459	434	411	...	...
	5/8	3/4	176.9	51.94	3.27	779	779	779	753	719	686	653	621	590	559	529	501	475	449	...	...
	5/8	7/8	188.9	55.44	3.33	832	832	832	808	774	740	705	670	637	605	574	544	516	488	...	...
	5/8	1	200.7	58.94	3.37	884	884	884	863	827	791	755	719	684	650	617	585	555	526	...	...
12×3/4	6×4×3/4	14×3/4	196.4	57.76	3.25	866	866	866	835	798	761	724	687	652	618	585	554	524	497	...	...
	3/4	7/8	208.4	61.26	3.30	919	919	919	891	852	814	775	737	700	664	629	596	565	536	...	...
	3/4	1	220.2	64.76	3.34	971	971	971	946	906	865	825	785	746	708	672	637	604	572	...	...
	6×4×7/8	14×7/8	222.8	65.42	3.29	981	981	981	950	909	867	826	785	746	707	670	635	601	570	...	...
	7/8	1	234.6	68.92	3.33	1034	1034	1034	1005	963	919	876	833	792	752	713	676	641	607	...	...
12×5/8	6×4×5/8	14×1 1/8	212.6	62.44	3.41	937	937	937	919	882	843	805	767	730	694	659	626	594	564	535	...
	5/8	1 1/4	224.5	65.94	3.45	989	989	989	975	935	895	855	816	777	739	703	668	634	602	572	...
	5/8	1 3/8	236.3	69.44	3.48	1042	1042	1042	1030	989	947	905	865	824	784	746	709	674	640	608	...
	5/8	1 1/2	248.3	72.94	3.51	1094	1094	1094	1085	1042	999	956	912	870	829	788	750	713	678	643	...
	6×4×5/8	14×1 5/8	260.3	76.44	3.54	1147	1147	1147	1140	1096	1051	1006	961	917	874	832	792	753	716	680	...
	5/8	1 3/4	272.3	79.94	3.56	1199	1199	1199	1194	1149	1102	1055	1009	962	917	874	831	791	753	715	...
	5/8	1 7/8	283.9	83.44	3.58	1252	1252	1252	1249	1202	1153	1105	1056	1008	962	917	873	830	790	751	...
	5/8	2	295.9	86.94	3.60	1304	1304	1304	1304	1255	1205	1155	1104	1055	1006	959	913	869	828	788	713

Columns above heavy horizontal line have no metal above 1″ thick.
Unequal Angles have short leg against web plate.
Weights given do not include rivets or other details.
Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 12½″ PLATE AND ANGLE COLUMNS WITH COVER PLATES

1 Web Plate	4 Angles	2 Cover Plates	DIMENSIONS d	b	t	h	m	o	g	c	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
12×⅜	6×4×⅜	14×⅜	13¼	14	1⅛	7½	2½	3½	7⅜	10¾	⅞	916	138.2	5.58	291	41.6	3.14
	⅜	½	13½	"	1⅛	"	"	"	"	"	"	1073	159.0	5.71	348	49.7	3.25
	7/16	½	"	"	1¼	"	"	"	"	10⅝	"	1136	168.3	5.68	368	52.6	3.23
	½	½	"	"	1⅜	"	"	"	"	10½	"	1197	177.4	5.65	388	55.4	3.22
12×½	6×4×½	14×½	13½	14	1½	7½	2½	3½	7½	10½	⅞	1215	180.0	5.58	394	56.3	3.18
	½	⅝	13¾	"	1½	"	"	"	"	"	"	1377	200.4	5.69	451	64.4	3.26
	9/16	⅝	"	"	1⅝	"	"	"	"	10⅜	"	1437	209.0	5.67	472	67.4	3.25
	⅝	⅝	"	"	1¾	"	"	"	"	10¼	"	1495	217.5	5.64	492	70.3	3.24
12×⅝	6×4×⅝	14×⅝	13¾	14	1⅞	7½	2½	3½	7⅝	10¼	⅞	1513	220.2	5.59	499	71.3	3.21
	⅝	¾	14	"	"	"	"	"	"	"	"	1682	240.3	5.69	556	79.4	3.27
	⅝	⅞	14¼	"	"	"	"	"	"	"	"	1856	260.6	5.79	613	87.6	3.33
	⅝	1	14½	"	"	"	"	"	"	"	"	2035	280.7	5.88	671	95.8	3.37
12×¾	6×4×¾	14×¾	14	14	2¼	7½	2½	3½	7¾	10	⅞	1808	258.3	5.60	609	87.0	3.25
	¾	⅞	14¼	"	"	"	"	"	"	"	"	1982	278.2	5.69	666	95.1	3.30
	¾	1	14½	"	"	"	"	"	"	"	"	2161	298.1	5.78	723	103.3	3.34
	6×4×⅞	14×⅞	14¼	"	2½	"	"	"	"	9¾	"	2085	292.6	5.64	710	101.4	3.29
	⅞	1	14½	"	"	"	"	"	"	"	"	2265	312.4	5.74	767	109.6	3.33
12×⅝	6×4×⅝	14×1⅛	14¾	14	1⅞	7½	2½	3½	7⅝	10¼	⅞	2224	302.0	5.97	728	104.0	3.41
	⅝	1¼	15	"	"	"	"	"	"	"	"	2418	322.4	6.06	785	112.1	3.45
	⅝	1⅜	15¼	"	"	"	"	"	"	"	"	2618	343.3	6.14	842	120.3	3.48
	⅝	1½	15½	"	"	"	"	"	"	"	"	2825	364.5	6.22	899	128.4	3.51
	6×4×⅝	14×1⅝	15¾	14	1⅞	7½	2½	3½	7⅝	10¼	⅞	3038	385.8	6.30	956	136.6	3.54
	⅝	1¾	16	"	"	"	"	"	"	"	"	3259	407.4	6.38	1014	144.8	3.56
	⅝	1⅞	16¼	"	"	"	"	"	"	"	"	3486	429.2	6.46	1071	153.0	3.58
	⅝	2	16½	"	"	"	"	"	"	"	"	3721	451.0	6.54	1128	161.1	3.60



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

12½″

Columns above heavy horizontal line have no metal above 1″ thick.
Unequal Angles have short leg against web plate.
Dimensions *h*, *m*, *o*, and *g* can be varied considerably.

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 14½″ PLATE AND ANGLE COLUMNS

[For 14½″ Columns with Cover Plates see following pages]

1 Web Plate	4 Angles	Weight Per Foot	Area Sq. in.	Least Radius Gyr.	UNSUPPORTED LENGTH IN FEET 6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
14×¼	3½×3 ×¼	33.5	9.74	1.29	146	134	118	104	90	79	68	60	...	...	...	...	...	...	...	...
	⅜	43.5	12.70	1.38	191	180	161	142	125	110	97	85	...	...	...	...	...	...	...	...
	4 ×3 ×¼	35.1	10.26	1.52	154	151	137	123	110	98	87	78	69	...	...	...	...	...	...	...
	⅜	45.9	13.42	1.62	201	201	185	168	151	136	122	109	98	...	...	...	...	...	...	...
	4 ×3½×⅜	48.3	14 18	1 59	213	212	194	175	157	141	126	113	101	...	...	...	...	...	...	...
	5 ×3½×5/16	46 7	13.74	2 03	206	206	206	194	179	165	152	139	127	117	107	98	90	...	...	...
	⅜	53 5	15.70	2 08	236	236	236	223	207	192	177	162	149	137	126	116	106	...	...	...
14×5/16	4 ×3 ×5/16	43.7	12 74	1 54	191	189	171	154	138	123	110	98	87	...	...	...	...	...	...	...
	⅜	48.9	14 30	1 59	215	214	195	177	159	142	127	114	102	...	...	...	...	...	...	...
	4 ×3½×⅜	51.3	15.06	1.56	226	224	204	184	165	147	131	117	105	...	...	...	...	...	...	...
	5 ×3½×5/16	49.7	14.62	1.98	219	219	219	204	188	173	158	145	132	121	111	101	93	...	...	...
	⅜	56.5	16 58	2 04	249	249	249	234	217	201	184	169	155	142	130	119	109	...	...	...
	6 ×4 ×⅜	64.1	18.82	2 50	282	282	282	282	271	255	239	224	209	195	182	169	157	...	...	...
	7/16	72.1	21 10	2 55	317	317	317	317	306	291	272	254	238	222	207	193	180	...	...	...
14×⅜	4 ×3 ×⅜	51.9	15.17	1.57	228	226	206	186	167	149	133	119	106	...	...	...	...	...	...	...
	4 ×3½×⅜	54.3	15 93	1.54	239	236	214	193	173	154	137	122	109	...	...	...	...	...	...	...
	5 ×3½×⅜	59.5	17,45	2.01	262	262	262	244	226	209	192	175	160	147	134	123	113	...	...	...
	7/16	65.9	19.37	2.06	291	291	291	274	255	235	217	199	182	167	153	140	129	...	...	...
	½	72.3	21.25	2.11	319	319	319	304	283	262	242	223	204	188	173	159	146	...	...	...
	6 ×4 ×⅜	67.1	19.69	2.46	295	295	295	295	282	265	248	232	216	201	187	174	162	151	140	...
	7/16	75 1	21.97	2 52	330	330	330	330	317	299	281	263	246	229	214	199	185	173	161	...
	½	82.7	24.25	2.57	364	364	364	364	353	333	314	294	275	257	240	224	209	195	182	...
	6 ×6 ×⅜	77.5	22.69	2 30	340	340	340	335	315	294	274	255	236	218	202	187	173	160	...	...
	7/16	86.7	25.49	2.34	382	382	382	379	357	334	311	290	269	249	231	214	198	184	...	...
	½	96.3	28 25	2 38	424	424	424	423	398	373	349	325	302	280	260	241	224	208	...	...
14×½	5 ×3½×½	78.2	23.00	2.07	345	345	345	326	303	280	258	237	218	199	183	168	155	...	...	...
	⅝	91.0	26.68	2.15	400	400	400	384	358	333	308	284	261	241	221	204	188	...	...	...
	6 ×4 ×½	88.6	26.00	2.52	390	390	390	390	375	354	332	311	291	271	253	235	219	204	191	178
	9/16	96.2	28 24	2.56	424	424	424	424	410	387	364	341	320	298	278	260	242	226	211	197
	⅝	103.8	30.44	2.60	457	457	457	457	445	420	396	372	348	326	304	284	265	248	231	216
	6 ×6 ×½	102.2	30.00	2.35	450	450	450	447	420	394	368	342	317	294	273	253	234	217	...	...
	9/16	111.4	32.72	2.39	491	491	491	490	462	434	405	378	351	326	303	281	260	242	...	...
	⅝	120.6	35 44	2.42	532	532	532	532	503	472	442	412	384	357	331	308	286	266	...	...
14×⅝	6 ×6 ×⅝	126 6	37.19	2.41	558	558	558	558	527	495	463	431	402	373	347	322	299	278	...	...
	¾	144.6	42.51	2.47	638	638	638	638	609	573	537	502	468	436	406	377	351	326	...	...
14×¾	6 ×6 ×¾	150 5	44.26	2.47	664	664	664	664	634	596	559	522	487	454	422	393	365	340	...	...
	⅞	168.1	49.42	2.53	741	741	741	741	714	674	633	593	554	517	482	449	419	390	364	340

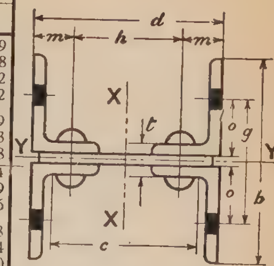
Unequal Angles have short leg against web plate.
Weights given do not include rivets or other details.
Loads to right of heavy vertical lines are for Secondary Members ONLY.

DIMENSIONS AND FUNCTIONS OF 14½″ PLATE AND ANGLE COLUMNS

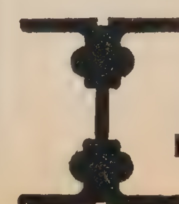
[For 14½″ Columns with Cover Plates see following pages]

1 Web Plate	4 Angles	DIMENSIONS d	b	t	h	m	o	g	c	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
14×¼	3½×3×¼	14½	7¼	¾	11	1¾	2	4¼	13¼	⅞	323	44.5	5.76	16	4.5	1.29
	⅜	"	"	1	"	"	"	"	13	"	444	61.2	5.91	24	6.7	1.38
	4×3×¼	"	8¼	¾	"	"	2½	5¼	13¼	"	349	44.7	5.83	24	5.8	1.52
	⅜	"	"	1	"	"	"	"	13	"	480	66.2	5.98	35	8.6	1.62
	4×3½×⅜	14½	8¼	1	10½	2	2½	5¼	13	⅞	492	67.8	5.89	36	8.7	1.59
	5×3½×5/16	"	10¼	⅞	"	"	3	6¼	13	"	489	67.5	5.97	57	11.0	2.03
	⅜	"	"	1	"	"	"	"	12⅞	"	568	78.4	6.02	68	13.2	2.08
14×5/16	4×3×5/16	14½	8 5/16	15/16	11	1¾	2½	5 5/16	13⅛	⅞	431	59.4	5.82	30	7.3	1.54
	⅜	"	"	1 1/16	"	"	"	"	13	"	495	68.2	5.88	36	8.7	1.59
	4×3½×⅜	"	"	"	10½	2	"	"	13	"	506	69.8	5.79	37	8.8	1.56
	5×3½×5/16	14½	10 5/16	15/16	10½	2	3	6 5/16	13	⅞	504	69.5	5.87	58	11.2	1.98
	⅜	"	"	1 1/16	"	"	"	"	12⅞	"	583	80.4	5.93	69	13.4	2.04
	6×4×⅜	"	12 5/16	"	9½	2½	3½	7 5/16	12¾	"	667	92.0	5.95	117	19.0	2.50
	7/16	"	"	1 3/16	"	"	"	"	12⅝	"	756	104.2	5.98	137	22.2	2.55
14×⅜	4×3×⅜	14½	8⅜	1⅛	11	1¾	2½	5⅜	13	⅞	509	70.2	5.79	37	8.9	1.57
	4×3½×⅜	"	"	"	10½	2	"	"	13	"	520	71.8	5.72	38	9.0	1.54
	5×3½×⅜	"	10⅜	"	"	"	3	6⅜	12⅞	"	597	82.3	5.85	71	13.6	2.01
	7/16	"	"	1¼	"	"	"	"	12¾	"	673	92.8	5.89	82	15.9	2.06
	½	"	"	1⅜	"	"	"	"	12⅝	"	745	102.7	5.92	95	18.3	2.11
	6×4×⅜	14½	12⅜	1⅛	9½	2½	3½	7⅜	12¾	⅞	681	94.0	5.88	119	19.3	2.46
	7/16	"	"	1¼	"	"	"	"	12⅝	"	770	106.2	5.92	139	22.5	2.52
	½	"	"	1⅜	"	"	"	"	12½	"	856	117.7	5.94	160	25.8	2.57
	6×6×⅜	"	"	1⅛	7½	3½	"	"	12¾	"	696	95.9	5.53	120	19.4	2.30
	7/16	"	"	1¼	"	"	"	"	12⅝	"	789	108.8	5.56	140	22.6	2.34
	½	"	"	1⅜	"	"	"	"	12½	"	879	121.2	5.58	160	25.8	2.38
14×½	5×3½×½	14½	10½	1½	10½	2	3	6½	12⅝	⅞	773	106.6	5.80	99	18.8	2.07
	⅝	"	"	1¾	"	"	"	"	12⅜	"	914	126.1	5.86	123	23.5	2.15
	6×4×½	"	12½	1½	9½	2½	3½	7½	12½	"	884	122.0	5.83	165	26.4	2.52
	9/16	"	"	1⅝	"	"	"	"	12⅜	"	969	133.6	5.86	186	29.7	2.56
	⅝	"	"	1¾	"	"	"	"	12¼	"	1051	145.0	5.88	206	33.0	2.60
	6×6×½	14½	12½	1½	7½	3½	3½	7½	12½	⅞	907	125.1	5.50	166	26.5	2.35
	9/16	"	"	1⅝	"	"	"	"	12⅜	"	992	136.8	5.51	187	30.0	2.39
	⅝	"	"	1¾	"	"	"	"	12¼	"	1077	148.6	5.52	208	33.3	2.42
14×⅝	6×6×⅝	14½	12⅝	1⅞	7½	3½	3½	7⅝	12¼	⅞	1106	152.6	5.46	216	34.1	2.41
	¾	"	"	2⅛	"	"	"	"	12	"	1266	174.7	5.46	261	41.2	2.47
14×¾	6×6×¾	14½	12¾	2¼	7½	3½	3½	7¾	12	⅞	1295	178.5	5.41	270	42.3	2.47
	⅞	"	"	2½	"	"	"	"	11¾	"	1447	199.6	5.41	316	49.5	2.53

Unequal Angles have short leg against web plate.
Dimensions *h*, *m*, *o*, and *g* can be varied considerably.



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration



14½″

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 14½″ PLATE AND ANGLE COLUMNS WITH COVER PLATES

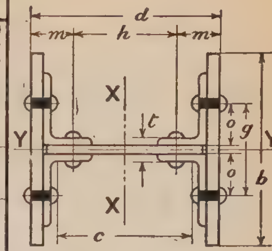
1 Web Plate	4 Angles	2 Cover Plates	Weight Per Foot	Area Sq. In.	Least Radius Gyr.	Unsupported Length In Feet: 12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	44
14×3/8	6×4×3/8	14×3/8	102.8	30.19	3.10	453	453	448	428	408	387	367	348	329	311	293	277	261	247	....	....
	7/16	3/8	110.8	32.47	3.09	487	487	481	460	438	416	394	373	353	333	314	297	280	264	....	....
	1/2	3/8	118.4	34.75	3.09	521	521	515	492	468	445	422	399	377	357	336	318	300	283	....	....
	1/2	7/16	124.3	36.50	3.14	548	548	544	520	496	472	448	424	402	380	359	339	320	303	....	....
	1/2	1/2	130.3	38.25	3.19	574	574	573	549	524	499	474	449	426	403	381	361	341	322	305	....
	1/2	9/16	136.2	40.00	3.23	600	600	600	577	551	525	500	474	450	426	403	382	361	342	323	....
	1/2	5/8	142.2	41.75	3.27	626	626	626	605	578	552	525	499	474	449	425	403	382	361	342	....
14×1/2	6×4×1/2	14×5/8	148.1	43.50	3.22	653	653	653	626	598	570	542	515	488	462	437	414	392	370	350	....
	9/16	5/8	155.7	45.74	3.21	686	686	686	658	628	598	569	540	512	484	458	434	410	388	367	....
	5/8	5/8	163.3	47.94	3.20	719	719	719	688	657	626	595	565	535	507	479	454	429	406	384	....
14×5/8	6×4×5/8	14×5/8	169.3	49.69	3.17	745	745	743	711	678	645	613	581	551	521	492	466	440	416	....	....
	5/8	3/4	181.2	53.19	3.23	798	798	798	767	732	698	664	631	598	566	536	507	480	454	430	....
	5/8	7/8	193.2	56.69	3.29	850	850	850	823	787	751	716	680	646	613	581	550	521	494	467	....
	5/8	1	205.0	60.19	3.34	903	903	903	879	842	804	767	729	693	658	625	592	562	532	504	....
14×3/4	6×6×3/4	14×3/4	221.9	65.26	3.06	979	979	964	920	876	831	787	745	703	664	626	591	557	525	....	....
	3/4	7/8	233.9	68.76	3.12	1031	1031	1022	978	932	885	840	796	752	711	672	635	599	566	....	....
	3/4	1	245.7	72.26	3.17	1084	1084	1080	1034	986	939	892	845	801	757	716	677	640	606	....	....
14×3/4	6×6×7/8	16×7/8	263.3	77.42	3.43	1161	1161	1161	1142	1095	1048	1001	955	909	865	821	780	741	702	667	602
	7/8	1	276.9	81.42	3.50	1221	1221	1221	1210	1162	1114	1065	1017	970	923	879	835	794	754	716	647
14×5/8	6×4×5/8	14×1 1/8	216.9	63.69	3.38	955	955	955	934	895	856	817	778	741	703	667	634	601	570	541	....
	5/8	1 1/4	228.8	67.19	3.42	1008	1008	1008	990	949	908	867	827	787	748	711	675	641	608	577	520
	5/8	1 3/8	240.6	70.69	3.45	1060	1060	1060	1045	1002	960	917	874	833	792	754	716	680	645	618	553
	5/8	1 1/2	252.6	74.19	3.48	1113	1113	1113	1100	1056	1012	967	924	880	838	797	757	720	683	649	586
	5/8	1 5/8	264.6	77.69	3.51	1165	1165	1165	1155	1109	1064	1018	972	927	883	840	799	759	722	685	620
	5/8	1 3/4	276.6	81.19	3.53	1218	1218	1218	1209	1163	1115	1067	1019	973	926	882	839	798	758	721	652
	5/8	1 7/8	288.3	84.69	3.56	1270	1270	1270	1265	1217	1168	1118	1069	1020	971	926	881	838	798	758	686
	5/8	2	300.2	88.19	3.58	1323	1323	1323	1320	1270	1219	1168	1116	1066	1017	969	923	877	835	794	719
14×5/8	6×4×5/8	16×1 7/8	313.8	92.19	4.02	1383	1383	1383	1383	1383	1340	1291	1244	1196	1148	1102	1056	1010	968	926	847
	5/8	2	327.4	96.19	4.05	1443	1443	1443	1443	1443	1401	1351	1302	1252	1203	1154	1107	1061	1016	972	891
14×5/8	6×6×5/8	16×2	344.2	101.19	3.95	1518	1518	1518	1518	1512	1459	1407	1353	1299	1247	1194	1143	1094	1046	1001	914
	5/8	2 1/8	357.8	105.19	3.98	1578	1578	1578	1578	1575	1521	1466	1411	1356	1302	1249	1195	1144	1095	1048	957
	5/8	2 1/4	371.4	109.19	4.01	1638	1638	1638	1638	1638	1584	1528	1471	1414	1357	1303	1248	1195	1144	1094	1001
	5/8	2 3/8	385.0	113.19	4.03	1698	1698	1698	1698	1698	1647	1587	1528	1470	1412	1355	1298	1244	1191	1140	1042
	5/8	2 1/2	398.6	117.19	4.05	1758	1758	1758	1758	1758	1706	1647	1587	1526	1466	1406	1349	1293	1238	1185	1085

Columns above heavy horizontal line have no metal above 1″ thick.
Unequal angles have short leg against web plate.
Weights given do not include rivets or other details.
Loads to right of heavy vertical lines are for secondary members ONLY.

LOADS BY A. I. S. C. SPECIFICATION.

DIMENSIONS AND FUNCTIONS OF 14½" PLATE AND ANGLE COLUMNS WITH COVER PLATES

1 Web Plate	4 Angles	2 Cover Plates	DIMENSIONS d	b	t	h	m	o	g	c	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
14×3/8	6×4×3/8	14×3/8	15¼	14	1⅛	9½	2½	3½	7⅜	12¾	⅞	1262	166	6.46	291	41.6	3.10
	7/16	3/8	"	"	1¼	"	"	"	"	12⅝	"	1351	177	6.45	311	44.4	3.09
	1/2	3/8	"	"	1⅜	"	"	"	"	12½	"	1437	189	6.42	331	47.3	3.09
	1/2	7/16	15⅜	"	"	"	"	"	"	"	"	1539	200	6.50	360	51.4	3.14
	1/2	1/2	15½	14	1⅜	9½	2½	3½	7⅜	12½	⅞	1644	212	6.56	389	55.6	3.19
	1/2	9/16	15⅝	"	"	"	"	"	"	"	"	1749	224	6.61	417	59.6	3.23
	1/2	5/8	15¾	"	"	"	"	"	"	"	"	1857	236	6.67	446	63.7	3.27
14×½	6×4×½	14×5/8	15¾	14	1½	9½	2½	3½	7½	12½	⅞	1885	240	6.58	451	64.4	3.22
	9/16	5/8	"	"	1⅝	"	"	"	"	12⅜	"	1970	250	6.56	472	67.4	3.21
	5/8	5/8	"	"	1¾	"	"	"	"	12¼	"	2053	261	6.54	492	70.3	3.20
14×5/8	6×4×5/8	14×5/8	15¾	14	1⅞	9½	2½	3½	7⅝	12¼	⅞	2081	265	6.47	499	71.3	3.17
	5/8	3/4	16	"	"	"	"	"	"	"	"	2302	288	6.58	556	79.4	3.23
	5/8	7/8	16¼	"	"	"	"	"	"	"	"	2529	311	6.68	613	87.6	3.29
	5/8	1	16½	"	"	"	"	"	"	"	"	2762	335	6.78	671	95.8	3.34
14×3/4	6×6×3/4	14×3/4	16	14	2¼	7½	3½	3½	7¾	12	⅞	2517	315	6.21	613	87.6	3.06
	3/4	7/8	16¼	"	"	"	"	"	"	"	"	2741	338	6.32	670	95.7	3.12
	3/4	1	16½	"	"	"	"	"	"	"	"	2977	361	6.42	727	103.8	3.17
14×3/4	6×6×7/8	16×7/8	16¼	16	2½	7½	3½	3½	7¾	11¾	⅞	3103	382	6.33	913	114.1	3.43
	7/8	1	16½	"	"	"	"	"	"	"	"	3371	409	6.43	998	124.8	3.50
14×5/8	6×4×5/8	14×1⅛	16¾	14	1⅞	9½	2½	3½	7⅝	12¼	⅞	3006	359	6.87	728	104.0	3.38
	5/8	1¼	17	"	"	"	"	"	"	"	"	3255	383	6.96	785	112.1	3.42
	5/8	1⅜	17¼	"	"	"	"	"	"	"	"	3512	408	7.05	842	120.3	3.45
	5/8	1½	17½	"	"	"	"	"	"	"	"	3776	432	7.13	899	128.4	3.48
	5/8	1⅝	17¾	14	1⅞	9½	2½	3½	7⅝	12¼	⅞	4048	456	7.22	956	136.5	3.51
	5/8	1¾	18	"	"	"	"	"	"	"	"	4327	481	7.30	1014	144.8	3.53
	5/8	1⅞	18¼	"	"	"	"	"	"	"	"	4615	506	7.38	1071	153.0	3.56
	5/8	2	18½	"	"	"	"	"	"	"	"	4910	531	7.46	1128	161.1	3.58
14×5/8	6×4×5/8	16×1⅞	18¼	16	1⅞	9½	2½	3½	7⅝	12¼	⅞	5120	561	7.45	1493	186.6	4.02
	5/8	2	18½	"	"	"	"	"	"	"	"	5457	590	7.53	1579	197.4	4.05
14×5/8	6×6×5/8	16×2	18½	16	1⅞	7½	3½	3½	7⅝	12¼	⅞	5484	593	7.36	1581	197.6	3.95
	5/8	2⅛	18¾	"	"	"	"	"	"	"	"	5830	622	7.44	1666	208.2	3.98
	5/8	2¼	19	"	"	"	"	"	"	"	"	6187	651	7.53	1752	219.0	4.01
	5/8	2⅜	19¼	"	"	"	"	"	"	"	"	6552	681	7.61	1837	229.6	4.03
	5/8	2½	19½	"	"	"	"	"	"	"	"	6928	711	7.69	1922	240.2	4.05



I. is Moment of Inertia
S. is Section Modulus
r. is Radius of Gyration

14½"

Sections above heavy horizontal line have no metal above 1" thick.
Unequal angles have short leg against web plate.
Dimensions *h*, *m*, *o* and *g* can be varied considerably.

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 10″ CHANNEL COLUMNS WITH COVER PLATES

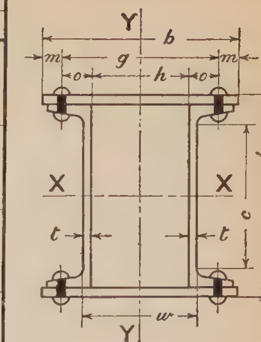
2 Channels	2 Cover Plates	Weight Per Foot	Area Sq. Inches	Least Radius Gyr.	14	16	18	20	22	24	26	28	30	32	34	36	38	40
					UNSUPPORTED LENGTH IN FEET													
10″ × 15.3#	12 × 1/4	51.0	14.19	3.62	213	213	213	205	197	189	181	173	165	157	150	143	136	129
	5/16	56.1	16.44	3.60	247	247	247	237	228	218	209	199	190	181	173	164	157	149
	3/8	61.2	17.94	3.59	269	269	269	259	248	238	228	217	207	197	188	179	170	162
	7/16	66.3	19.44	3.58	292	292	291	280	269	257	246	235	224	214	203	193	184	175
	1/2	71.4	20.94	3.57	314	314	313	301	289	277	265	253	241	230	218	208	198	188
10″ × 20.0#	12 × 1/4	60.4	16.97	3.53	255	255	253	243	233	223	213	203	194	184	175	167	159	151
	5/16	65.5	19.22	3.52	288	288	286	275	264	252	241	230	219	208	198	188	179	170
	3/8	70.6	20.72	3.51	311	311	308	296	284	271	259	247	235	224	213	202	192	183
	7/16	75.7	22.22	3.51	333	333	330	317	304	291	278	265	252	240	228	217	206	196
	1/2	80.8	23.72	3.51	356	356	353	339	325	311	297	283	269	256	244	232	220	209
10″ × 25.0#	12 × 1/4	70.4	19.91	3.45	299	299	294	282	270	258	246	235	223	212	202	192	182	173
	5/16	75.5	22.16	3.45	332	332	328	314	301	287	274	261	248	236	225	213	202	192
	3/8	80.6	23.66	3.45	355	355	350	336	321	307	293	279	265	252	240	228	216	205
	1/2	90.8	26.66	3.45	400	400	394	378	362	346	330	314	299	284	270	257	243	231
	5/8	101.0	29.66	3.45	445	445	438	421	403	385	367	349	333	316	301	285	271	257
10″ × 30.0#	12 × 1/4	80.4	22.85	3.33	343	343	333	319	305	290	276	263	249	237	224	213	201	191
	5/16	85.5	25.10	3.34	377	377	367	351	335	320	304	289	275	261	250	234	222	210
	3/8	90.6	26.60	3.35	399	399	389	373	356	339	323	307	292	277	265	249	236	224
	12 × 1/2	100.8	29.60	3.36	444	444	433	415	397	378	360	343	325	309	293	278	263	250
	5/8	111.0	32.60	3.37	489	489	478	458	438	418	398	378	359	341	323	307	291	276
	3/4	121.2	35.60	3.38	534	534	522	501	479	457	435	414	393	373	354	336	319	302
10″ × 35.0#	12 × 1/4	90.4	25.79	3.25	387	387	373	356	340	323	307	291	276	261	247	234	222	210
	5/16	95.5	28.04	3.27	421	421	406	389	370	353	335	318	302	286	271	256	243	230
	3/8	100.6	29.54	3.28	443	443	429	410	391	372	354	336	318	302	286	271	256	243
	12 × 1/2	110.8	32.54	3.30	488	488	473	453	432	412	392	372	353	334	317	300	284	269
	5/8	121.0	35.54	3.31	533	533	518	495	473	450	428	407	386	366	347	329	311	295
	3/4	131.2	38.54	3.33	578	578	562	539	514	490	466	443	421	399	378	358	340	322

The 1/4″ Plates are tabulated with all weights of Channels, as adding some sectional area, without costing appreciably more than lattice bars and batten plates; 87½% of their area is included in the functions and column areas.
Weights given do not include rivets or other details.
Loads to right of heavy vertical lines are for secondary members ONLY.

DIMENSIONS AND FUNCTIONS OF 10″ CHANNEL COLUMNS WITH COVER PLATES

2 Channels	2 Cover Plates	DIMENSIONS d	b	w	c	g	m	h	o	t	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
10″ × 15.3#	12 × 1/4	10 1/2	12	6 1/2	8 3/16	9	1 1/2	6	1 1/2	.240	3/4	272	51.8	4.38	186	31.0	3.62
	5/16	10 5/8	“	“	“	“	“	“	“	“	“	333	62.7	4.50	213	35.5	3.60
	3/8	10 3/4	“	“	“	“	“	“	“	“	“	376	70.0	4.58	231	38.5	3.59
	7/16	10 7/8	“	“	“	“	“	“	“	“	“	420	77.2	4.65	249	41.5	3.58
	1/2	11	“	“	“	“	“	“	“	“	“	465	84.5	4.71	267	44.5	3.57
10″ × 20.0#	12 × 1/4	10 1/2	12	6 1/2	8 3/16	9	1 1/2	5 3/4	1 5/8	.379	3/4	295	56.2	4.17	211	35.2	3.53
	5/16	10 5/8	“	“	“	“	“	“	“	“	“	356	67.1	4.31	238	39.7	3.52
	3/8	10 3/4	“	“	“	“	“	“	“	“	“	399	74.3	4.39	256	42.7	3.51
	7/16	10 7/8	“	“	“	“	“	“	“	“	“	443	81.5	4.46	274	45.7	3.51
	1/2	11	“	“	“	“	“	“	“	“	“	488	88.7	4.53	292	48.7	3.51
10″ × 25.0#	12 × 1/4	10 1/2	12	6 1/2	8 3/16	9	1 1/2	5 1/2	1 3/4	.526	3/4	319	60.8	4.00	236	39.4	3.45
	5/16	10 5/8	“	“	“	“	“	“	“	“	“	381	71.7	4.15	263	43.9	3.45
	3/8	10 3/4	“	“	“	“	“	“	“	“	“	424	78.8	4.23	281	46.9	3.45
	1/2	11	“	“	“	“	“	“	“	“	“	512	93.1	4.38	317	52.9	3.45
	5/8	11 1/4	“	“	“	“	“	“	“	“	“	605	107.5	4.52	353	58.9	3.45
10″ × 30.0#	12 × 1/4	10 1/2	12	6 1/2	8 3/16	9	1 1/2	5 1/8	1 15/16	.673	3/4	344	65.5	3.88	253	42.1	3.33
	5/16	10 5/8	“	“	“	“	“	“	“	“	“	405	76.3	4.02	280	46.6	3.34
	3/8	10 3/4	“	“	“	“	“	“	“	“	“	448	83.4	4.10	298	49.6	3.35
	12 × 1/2	11	12	6 1/2	8 3/16	9	1 1/2	5 1/8	1 15/16	.673	3/4	537	97.6	4.26	334	55.6	3.36
	5/8	11 1/4	“	“	“	“	“	“	“	“	“	629	111.9	4.39	370	61.6	3.37
	3/4	11 1/2	“	“	“	“	“	“	“	“	“	726	126.3	4.52	406	67.6	3.38
10″ × 35.0#	12 × 1/4	10 1/2	12	6 1/2	8 3/16	9	1 1/2	4 7/8	2 1/16	.820	3/4	368	70.2	3.78	275	45.9	3.25
	5/16	10 5/8	“	“	“	“	“	“	“	“	“	430	80.9	3.92	300	50.0	3.27
	3/8	10 3/4	“	“	“	“	“	“	“	“	“	473	87.9	4.00	318	53.0	3.28
	12 × 1/2	11	12	6 1/2	8 3/16	9	1 1/2	4 7/8	2 1/16	.820	3/4	561	102.0	4.15	354	59.0	3.30
	5/8	11 1/4	“	“	“	“	“	“	“	“	“	654	116.2	4.29	390	65.0	3.31
	3/4	11 1/2	“	“	“	“	“	“	“	“	“	751	130.6	4.41	426	71.0	3.33

.875 of 12″ × 1/4″ plates used in areas and functions.



I. is Moment of Inertia.
S. is Section Modulus.
r. is Radius of Gyration.

10″

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 12″ CHANNEL COLUMNS WITH COVER PLATES

2 Channels	2 Cover Plates	Weight Per Foot	Area Sq. Inches	Least Radius Gyr.	Unsupported Length in Feet: 18	20	22	24	26	28	30	32	34	36	38	40	42	44
12″ × 20.7#	14 × 1/4	65.2	17.31	4.38	260	260	259	251	243	235	227	218	210	202	195	187	180	172
	5/16	71.2	20.81	4.33	312	312	310	301	291	281	271	261	251	241	232	223	214	205
	3/8	77.1	22.56	4.30	338	338	336	325	314	303	292	281	271	260	250	240	230	221
	14 × 7/16	83.1	24.31	4.29	365	365	361	350	338	326	315	303	291	280	269	258	248	238
	1/2	89.0	26.06	4.27	391	391	387	374	362	349	336	324	311	299	287	275	264	253
	5/8	100.9	29.56	4.24	443	443	438	424	409	394	380	366	351	338	324	311	298	286
12″ × 25.0#	14 × 1/4	73.8	19.89	4.29	298	298	296	286	277	267	257	248	238	229	220	211	203	194
	5/16	79.8	23.39	4.25	351	351	347	335	324	312	301	290	279	268	257	246	236	226
	3/8	85.7	25.14	4.24	377	377	372	360	348	335	323	311	299	287	276	265	253	243
	14 × 7/16	91.7	26.89	4.23	404	404	398	385	372	358	345	332	319	307	294	282	271	259
	1/2	97.6	28.64	4.22	430	430	423	410	396	381	367	353	339	326	313	300	288	276
	5/8	109.5	32.14	4.20	482	482	474	459	443	427	411	395	380	365	350	335	321	308
12″ × 30.0#	14 × 1/4	83.8	22.83	4.20	343	343	337	326	315	303	292	281	270	259	248	238	228	219
	5/16	89.8	26.33	4.18	395	395	388	375	362	349	336	323	310	298	285	273	262	251
	3/8	95.7	28.08	4.17	421	421	413	400	386	372	358	344	330	317	304	291	279	267
	14 × 1/2	107.6	31.58	4.16	474	474	465	449	433	417	401	386	370	356	341	327	313	300
	5/8	119.5	35.08	4.15	526	526	516	498	481	463	445	428	411	394	378	362	347	333
	3/4	131.4	38.58	4.14	579	579	566	547	528	508	489	470	451	433	415	398	381	365
12″ × 35.0#	14 × 1/4	93.8	25.77	4.12	387	387	378	365	352	339	326	313	300	288	276	264	253	242
	5/16	99.8	29.27	4.11	439	439	429	414	399	384	369	355	341	326	313	300	287	275
	3/8	105.7	31.02	4.10	465	465	454	438	422	407	391	375	360	345	331	317	304	291
	1/2	117.6	34.52	4.10	518	518	505	488	470	453	435	418	401	384	368	353	338	323
	14 × 5/8	129.5	38.02	4.09	570	570	556	536	517	498	478	459	441	422	405	388	371	355
	3/4	141.4	41.52	4.09	623	623	607	586	565	543	522	502	481	461	442	424	406	388
	7/8	153.4	45.02	4.08	675	675	657	635	612	588	565	543	521	499	479	458	438	420
	1	165.2	48.52	4.08	728	728	708	684	659	634	609	585	561	538	516	493	473	452
12″ × 40.0#	14 × 1/4	103.8	28.71	4.04	431	431	418	403	388	373	359	344	330	316	303	289	277	265
	5/16	109.8	32.21	4.04	483	483	469	452	436	419	402	386	370	355	340	325	311	298
	3/8	115.7	33.96	4.04	509	509	494	477	459	441	424	407	390	374	358	342	328	314
	1/2	127.6	37.46	4.04	562	562	545	526	506	487	468	449	430	412	395	378	361	346
	14 × 5/8	139.5	40.96	4.04	614	614	596	575	554	532	512	491	471	451	432	413	395	378
	3/4	151.4	44.46	4.04	667	667	647	624	601	578	555	533	511	490	469	448	429	411
	7/8	163.4	47.96	4.04	719	719	698	673	648	623	599	575	551	528	505	483	463	443
	1	175.2	51.46	4.04	772	772	749	722	696	669	643	616	591	567	542	519	497	475

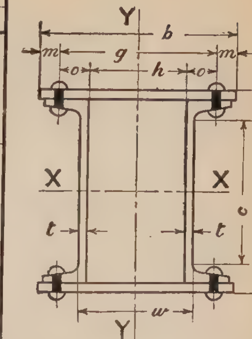
The 1/4″ Plates are tabulated with all weights of Channels, as adding some sectional area, without costing appreciably more than lattice bars and batten plates: 75% of their area is included in the functions and column areas.
Weights given do not include Rivets or other details.
Loads to right of heavy vertical lines are for secondary members ONLY.

LOADS BY A. I. S. C. SPECIFICATION

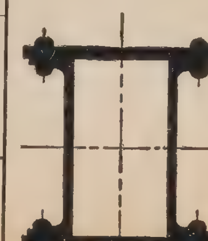
DIMENSIONS AND FUNCTIONS OF 12″ CHANNEL COLUMNS WITH COVER PLATES

2 Channels	2 Cover Plates	DIMENSIONS										AXIS X-X			AXIS Y-Y		
		d	b	w	c	g	m	h	o	t	Riv.	I	S	r	I	S	r
12″ × 20.7#	14 × 1/4	12½	14	8	10	11	1½	7½	1¾	280	¾	453	72.5	5.12	332	47.5	4.38
	5/16	12⅝	"	"	"	"	"	"	"	"	"	588	93.1	5.31	390	55.6	4.33
	3/8	12¾	"	"	"	"	"	"	"	"	"	658	103.3	5.40	418	59.7	4.30
	14 × 7/16	12⅞	14	8	10	11	1½	7½	1¾	.280	¾	731	113.6	5.48	447	63.8	4.29
	1/2	13	"	"	"	"	"	"	"	"	"	804	123.7	5.56	475	67.9	4.27
	5/8	13¼	"	"	"	"	"	"	"	"	"	954	143.9	5.68	532	76.1	4.24
12″ × 25.0#	14 × 1/4	12½	14	8	10	11	1½	7¼	1⅞	.387	¾	484	77.4	4.93	366	52.3	4.29
	5/16	12⅝	"	"	"	"	"	"	"	"	"	619	98.0	5.14	423	60.5	4.25
	3/8	12¾	"	"	"	"	"	"	"	"	"	689	108.1	5.23	452	64.5	4.24
	14 × 7/16	12⅞	14	8	10	11	1½	7¼	1⅞	.387	¾	762	118.2	5.32	480	68.6	4.23
	1/2	13	"	"	"	"	"	"	"	"	"	835	128.4	5.40	509	72.7	4.22
	5/8	13¼	"	"	"	"	"	"	"	"	"	984	148.6	5.53	566	80.9	4.20
12″ × 30.0#	14 × 1/4	12½	14	8	10	11	1½	7	2	.510	¾	519	83.1	4.77	403	57.6	4.20
	5/16	12⅝	"	"	"	"	"	"	"	"	"	654	103.6	4.98	460	65.8	4.18
	3/8	12¾	"	"	"	"	"	"	"	"	"	724	113.6	5.08	489	69.9	4.17
	14 × 1/2	13	14	8	10	11	1½	7	2	.510	¾	870	133.9	5.25	546	78.0	4.16
	5/8	13¼	"	"	"	"	"	"	"	"	"	1020	153.9	5.39	603	86.2	4.15
	3/4	13½	"	"	"	"	"	"	"	"	"	1176	174.2	5.52	661	94.4	4.14
12″ × 35.0#	14 × 1/4	12½	14	8	10	11	1½	6¾	2⅛	.632	¾	555	88.7	4.64	437	62.4	4.12
	5/16	12⅝	"	"	"	"	"	"	"	"	"	689	109.2	4.85	494	70.5	4.11
	3/8	12¾	"	"	"	"	"	"	"	"	"	760	119.2	4.95	522	74.6	4.10
	1/2	13	"	"	"	"	"	"	"	"	"	905	139.2	5.12	580	82.8	4.10
	14 × 5/8	13¼	14	8	10	11	1½	6¾	2⅛	.632	¾	1055	159.2	5.27	637	91.0	4.09
	3/4	13½	"	"	"	"	"	"	"	"	"	1212	179.5	5.40	694	99.1	4.09
	7/8	13¾	"	"	"	"	"	"	"	"	"	1374	199.8	5.52	751	107.3	4.08
	1	14	"	"	"	"	"	"	"	"	"	1543	220.3	5.64	808	115.5	4.08
12″ × 40.0#	14 × 1/4	12½	14	8	10	11	1½	6½	2¼	.755	¾	590	94.4	4.53	469	67.0	4.04
	5/16	12⅝	"	"	"	"	"	"	"	"	"	725	114.8	4.74	526	75.1	4.04
	3/8	12¾	"	"	"	"	"	"	"	"	"	795	124.7	4.84	554	79.2	4.04
	1/2	13	"	"	"	"	"	"	"	"	"	940	144.6	5.01	612	87.4	4.04
	14 × 5/8	13¼	14	8	10	11	1½	6½	2¼	.755	¾	1090	164.6	5.16	669	95.5	4.04
	3/4	13½	"	"	"	"	"	"	"	"	"	1247	184.7	5.29	726	103.7	4.04
	7/8	13¾	"	"	"	"	"	"	"	"	"	1409	204.9	5.42	783	111.9	4.04
	1	14	"	"	"	"	"	"	"	"	"	1578	225.4	5.53	840	120.0	4.04

.75 of 14″ × ¼″ plates used in areas and functions.



I. is Moment of Inertia.
S. is Section Modulus.
r. is Radius of Gyration



12″

ALLOWABLE CONCENTRIC LOADS IN KIPS FOR 15″ CHANNEL COLUMNS WITH COVER PLATES

2 Channels	2 Cover Plates	Weight Per Foot	Area Sq. Inches	Least Radius Gyr.	UNSUPPORTED LENGTH IN FEET													
					20	22	24	26	28	30	32	34	36	38	40	42	44	46
15″ × 33.9#	16 × 1/4	95.0	25.05	5.12	376	376	376	374	364	354	343	333	323	313	303	293	283	274
	3/8	108.6	31.80	5.02	477	477	477	471	458	445	432	419	405	392	379	367	355	342
	7/16	115.4	33.80	5.00	507	507	507	500	486	473	458	444	430	416	402	389	376	363
	16 × 1/2	122.2	35.80	4.98	537	537	537	529	514	499	484	469	454	439	425	411	397	383
	5/8	135.8	39.80	4.94	597	597	597	586	570	553	537	520	503	486	470	454	438	423
	3/4	149.4	43.80	4.91	657	657	657	644	625	607	589	570	551	533	515	498	480	463
15″ × 35.0#	16 × 1/4	97.2	25.71	5.07	386	386	386	382	372	361	351	340	330	319	309	299	289	279
	3/8	110.8	32.46	4.98	487	487	487	480	467	453	439	426	412	398	385	372	360	348
	1/2	124.4	36.46	4.94	547	547	547	537	522	507	491	476	461	446	430	416	401	387
	16 × 5/8	138.0	40.46	4.91	607	607	607	595	578	561	544	526	509	492	475	460	443	428
	3/4	151.6	44.46	4.89	667	667	667	653	634	615	596	577	558	540	521	503	486	469
	7/8	165.2	48.46	4.87	727	727	727	710	690	669	648	628	607	586	566	547	528	509
15″ × 40.0#	16 × 1/4	107.2	28.65	5.02	430	430	430	425	413	401	389	377	365	354	342	331	319	308
	3/8	120.8	35.40	4.95	531	531	531	522	507	492	478	463	448	433	418	404	391	377
	1/2	134.4	39.40	4.92	591	591	591	580	563	546	530	513	496	480	464	448	433	417
	16 × 5/8	148.0	43.40	4.89	651	651	651	637	619	600	582	563	545	527	509	491	474	457
	3/4	161.6	47.40	4.87	711	711	711	695	675	655	634	614	593	574	554	535	516	498
	7/8	175.2	51.40	4.85	771	771	771	752	730	708	686	664	642	620	599	578	558	538
15″ × 45.0#	16 × 1/4	117.2	31.59	4.93	474	474	474	465	452	439	426	412	399	385	372	360	347	335
	1/2	144.4	42.34	4.86	635	635	635	620	602	584	566	548	530	512	495	477	460	444
	5/8	158.0	46.34	4.84	695	695	695	677	658	638	618	598	578	558	539	520	502	484
	3/4	171.6	50.34	4.82	755	755	755	735	713	692	670	648	627	605	584	564	544	524
	16 × 7/8	185.2	54.34	4.80	815	815	815	792	769	745	722	698	674	652	629	606	585	564
	1″	198.8	58.34	4.79	875	875	875	849	824	799	774	749	723	698	674	650	627	604
	1 1/8	212.4	62.34	4.78	935	935	934	907	880	853	826	799	772	745	719	694	669	645
	1 1/4	226.0	66.34	4.77	995	995	993	965	936	907	878	849	820	792	764	737	711	685
15″ × 50.0#	16 × 1/4	127.2	34.53	4.89	518	518	518	507	492	478	463	448	434	419	405	391	377	364
	1/2	154.4	45.28	4.83	679	679	679	662	643	623	603	584	564	545	526	508	490	472
	5/8	168.0	49.28	4.81	739	739	739	719	698	677	655	634	613	592	571	551	531	512
	3/4	181.6	53.28	4.80	799	799	799	777	754	731	708	684	661	639	616	595	573	553
	16 × 7/8	195.2	57.28	4.79	859	859	859	834	809	785	760	735	710	686	662	638	616	593
	1″	208.8	61.28	4.78	919	919	918	892	865	838	812	785	759	732	707	682	658	634
	1 1/8	222.4	65.28	4.77	979	979	977	949	921	892	864	836	807	779	752	725	699	674
	1 1/4	236.0	69.28	4.76	1039	1039	1036	1007	977	946	916	885	856	826	797	768	741	714
15″ × 50.0#	18 × 1/4	130.6	34.53	5.67	518	518	518	518	518	507	495	483	470	457	444	432	420	407
	3/4	191.8	56.28	5.59	844	844	844	844	844	823	803	782	761	740	719	698	677	657
	7/8	207.2	60.78	5.56	912	912	912	912	909	887	865	842	819	796	774	751	729	707
	1″	222.4	65.28	5.54	979	979	979	979	976	952	928	903	879	854	829	805	781	757
	18 × 1 1/8	237.7	69.78	5.51	1047	1047	1047	1047	1041	1015	989	963	936	910	883	858	832	807
	1 1/4	253.0	74.28	5.49	1114	1114	1114	1114	1107	1079	1051	1023	995	966	938	911	883	856
	1 3/8	268.4	78.78	5.48	1182	1182	1182	1182	1173	1144	1114	1084	1054	1024	994	964	935	906
	1 1/2	283.6	83.28	5.46	1249	1249	1249	1249	1238	1208	1176	1144	1112	1080	1048	1018	987	956

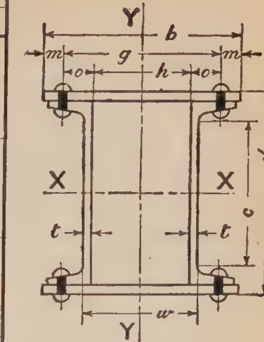
The 1/4″ Plates are tabulated with all weights of Channels, as adding some sectional area, without costing appreciably more than lattice bars and batten plates; 65 5/8% of the 16″ × 1/4″ and 58 1/3% of the 18″ × 1/4″ plates are included in the functions and column areas. Weights given do not include Rivets or other details.

LOADS BY A. I. S. C. SPECIFICATION

DIMENSIONS AND FUNCTIONS OF 15″ CHANNEL COLUMNS WITH COVER PLATES

2 Channels	2 Cover Plates	DIMENSIONS d	b	w	c	g	m	h	o	t	Riv.	AXIS X-X I	S	r	AXIS Y-Y I	S	r
15″ × 33.9#	16 × 1/4	15½	16	9½	12⅜	13	1½	8¾	2⅛	.400	⅞	930	120.1	6.09	657	82.1	5.12
	3/8	15¾	"	"	"	"	"	"	"	"	"	1334	169.4	6.48	801	100.1	5.02
	7/16	15⅞	"	"	"	"	"	"	"	"	"	1459	183.9	6.57	843	105.4	5.00
	16 × 1/2	16	16	9½	12⅜	13	1½	8¾	2⅛	.400	⅞	1587	198.3	6.66	886	110.7	4.98
	5/8	16¼	"	"	"	"	"	"	"	"	"	1846	227.3	6.81	971	121.4	4.94
	3/4	16½	"	"	"	"	"	"	"	"	"	2115	256.3	6.95	1057	132.1	4.91
15″ × 35.0#	16 × 1/4	15½	16	9½	12⅜	13	1½	8⅝	2 3/16	.422	⅞	943	121.6	6.06	661	82.7	5.07
	3/8	15¾	"	"	"	"	"	"	"	"	"	1347	171.0	6.44	805	100.7	4.98
	1/2	16	"	"	"	"	"	"	"	"	"	1599	199.9	6.62	891	111.4	4.94
	16 × 5/8	16¼	16	9½	12⅜	13	1½	8⅝	2 3/16	.422	⅞	1859	228.8	6.78	976	122.0	4.91
	3/4	16½	"	"	"	"	"	"	"	"	"	2127	257.8	6.92	1061	132.7	4.89
	7/8	16¾	"	"	"	"	"	"	"	"	"	2403	287.0	7.04	1147	143.4	4.87
15″ × 40.0#	16 × 1/4	15½	16	9½	12⅜	13	1½	8½	2¼	.520	⅞	998	128.7	5.90	723	90.3	5.02
	3/8	15¾	"	"	"	"	"	"	"	"	"	1402	178.0	6.29	867	108.3	4.95
	1/2	16	"	"	"	"	"	"	"	"	"	1654	206.8	6.48	952	119.0	4.92
	16 × 5/8	16¼	16	9½	12⅜	13	1½	8½	2¼	.520	⅞	1914	235.5	6.64	1037	129.7	4.89
	3/4	16½	"	"	"	"	"	"	"	"	"	2182	264.5	6.78	1123	140.3	4.87
	7/8	16¾	"	"	"	"	"	"	"	"	"	2458	293.5	6.92	1208	151.0	4.85
15″ × 45.0#	16 × 1/4	15½	16	9½	12⅜	13	1½	8¼	2⅜	.618	⅞	1053	135.9	5.77	769	96.1	4.93
	1/2	16	"	"	"	"	"	"	"	"	"	1709	213.7	6.35	998	124.8	4.86
	5/8	16¼	"	"	"	"	"	"	"	"	"	1969	242.4	6.52	1084	135.5	4.84
	3/4	16½	"	"	"	"	"	"	"	"	"	2237	271.2	6.67	1169	146.1	4.82
	16 × 7/8	16¾	16	9½	12⅜	13	1½	8¼	2⅜	.618	⅞	2514	300.1	6.80	1254	156.8	4.80
	1″	17	"	"	"	"	"	"	"	"	"	2798	329.2	6.93	1340	167.5	4.79
	1⅛	17¼	"	"	"	"	"	"	"	"	"	3092	358.4	7.04	1425	178.1	4.78
	1¼	17½	"	"	"	"	"	"	"	"	"	3393	387.8	7.15	1510	188.8	4.77
15″ × 50.0#	16 × 1/4	15½	16	9½	12⅜	13	1½	8⅛	2 7/16	.716	⅞	1108	143.0	5.67	827	103.3	4.89
	1/2	16	"	"	"	"	"	"	"	"	"	1764	220.5	6.24	1056	132.0	4.83
	5/8	16¼	"	"	"	"	"	"	"	"	"	2024	249.1	6.41	1141	142.7	4.81
	3/4	16½	"	"	"	"	"	"	"	"	"	2292	277.8	6.56	1227	153.3	4.80
	16 × 7/8	16¾	16	9½	12⅜	13	1½	8⅛	2 7/16	.716	⅞	2569	306.7	6.70	1312	164.0	4.79
	1″	17	"	"	"	"	"	"	"	"	"	2854	335.8	6.82	1397	174.7	4.78
	1⅛	17¼	"	"	"	"	"	"	"	"	"	3147	364.8	6.94	1483	185.3	4.77
	1¼	17½	"	"	"	"	"	"	"	"	"	3448	394.1	7.06	1568	196.0	4.76
15″ × 50.0#	18 × 1/4	15½	18	11½	12⅜	15	1½	10⅛	2 7/16	.716	⅞	1108	143.0	5.67	1170	130.1	5.82
	3/4	16½	"	"	"	"	"	"	"	"	"	2478	300.4	6.64	1758	195.3	5.59
	7/8	16¾	"	"	"	"	"	"	"	"	"	2789	333.1	6.77	1879	208.8	5.56
	1″	17	"	"	"	"	"	"	"	"	"	3110	365.9	6.90	2001	222.3	5.54
	18 × 1⅛	17¼	18	11½	12⅜	15	1½	10⅛	2 7/16	.716	⅞	3440	398.8	7.02	2122	235.8	5.51
	1¼	17½	"	"	"	"	"	"	"	"	"	3779	431.9	7.13	2244	249.3	5.49
	1⅜	17¾	"	"	"	"	"	"	"	"	"	4129	465.2	7.24	2365	262.8	5.48
	1½	18	"	"	"	"	"	"	"	"	"	4488	498.7	7.34	2487	276.3	5.46

.65625 of 16″ × ¼″ plates used in areas and functions.
.58333 of 18″ × ¼″ plates used in areas and functions.



I. is Moment of Inertia.
S. is Section Modulus.
r. is Radius of Gyration.

15″

NOTES and DIAGRAMS

Part IV

Section 13

Steel Slab Column Bases

SOLID STEEL SLABS FOR COLUMN BASES

The size of slabs that can now be rolled is limited by the size of the ingot produced and the capacity of the rolling mill. Slabs have been rolled up to 120″ x 120″ x 9″ thick, weighing 36,000 #, and can be rolled up to 12″ thick and weighing 40,000 #.

Rolled steel slabs, especially those 2″ thick and over, are likely to be more or less bowed flatwise. If the material is sheared hot there will be 3″ to 5″ of deformation adjacent to the shear. All slabs over 2½″ thick and those 2½″ thick with a carbon content of more than .25% must be cut with a flame cutting torch. Slabs cut with the flame cutting torch do not show deformation adjacent to the cut. All slabs 4″ and under in thickness can be straightened by a press, but those thicker than 4″ must be machine faced where accuracy is required.

When ordering material for rolled steel slabs the following is suggested:

Specify ordinary Open Hearth steel with a carbon content of .10% to .25% and without incorporating the same physical requirements as fixed for structural steel.

Show finished dimensions only and state whether material is required hot sheared or flame cut to length.

Show what machining is to be done, namely on one face, both faces, or possibly both faces and four edges.

The mill should be instructed to add to these specified dimensions sufficient material to allow for machined finish.

Below is a table giving the width and thickness of material as usually rolled for slab use. The range of sizes will be found sufficient to cover any but very special cases, and as stated above the mills are now able to furnish slabs up to 12″ in thickness and 40,000 # in weight.

TABLE I

AVAILABLE SIZES OF STEEL SLABS

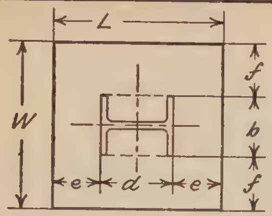
Width	Thickness	Length	Weight per Linear In.	Width	Thickness	Length	Weight per Linear In.
16″	2″	6′-8″ to 60′- 0″	9.07	44″	6	11′-3″ to 14′-2″	74.80
20	2	6′-8″ to 50′- 0″	11.33	48	5½	11′-3″ to 14′-0″	74.80
20	2½	6′-8″ to 36′- 8″	14.17	48	6	11′-3″ to 14′-0″	81.60
24	2½	6′-8″ to 36′- 8″	17.00	48	6½	9′-7″ to 12′-0″	88.40
24	3	6′-8″ to 24′- 2″	20.40	52	6	11′-3″ to 14′-7″	88.40
28	3	6′-8″ to 24′- 2″	23.80	52	6½	9′-7″ to 12′-6″	95.77
28	3½	6′-8″ to 18′- 4″	27.77	56	6½	10′-0″ to 11′-8″	103.10
32	3½	6′-8″ to 18′- 4″	31.73	56	7	10′-0″ to 11′-8″	111.07
32	4	6′-8″ to 18′- 4″	36.27	60	7		119.00
36	4	6′-8″ to 22′-11″	40.80	60	8		136.00
36	4½	6′-8″ to 22′-11″	45.90	66	8		149.60
40	4½	6′-8″ to 20′-10″	51.00	66	9		168.30
40	5	6′-8″ to 20′-10″	56.67	72	9		183.60
44	5	13′-9″ to 17′- 1″	62.33	72	10		204.00
44	5½	11′-3″ to 14′- 2″	68.57				

TABLE II

AVERAGE ALLOWABLE UNIT PRESSURES ON MASONRY IN POUNDS PER SQUARE INCH

Common Brick — Lime Mortar	= 100		Sandstone — Port. Cem. Mortar	= 400
Rubble Masonry — Lime Mortar	= 150		Limestone — Port. Cem. Mortar	= 500
Common Brick — Port. Cem. Mortar	= 200		Concrete — Port. Cement 1:2:4	= 600
Rubble Masonry — Port. Cem. Mortar	= 200		Granite — Port. Cem. Mortar	= 800
Hard Brick — Port. Cem. Mortar	= 250			

SOLID STEEL SLABS FOR COLUMN BASES



C = Total Load on Column in pounds
L = Length of Slab in inches
W = Width of Slab in inches
d = depth of Column in inches
b = width of Column in inches
A = Area of the Slab = L x W
U = Unit pressure per square inch on lower side of slab = C ÷ A

The column is assumed as having uniform bearing on the slab over the entire area of the milled end of the column shaft. It is also assumed that a part of the slab which is the smallest rectangle which will enclose the column cross section will act as a continuation of the column and that the maximum bending moment in the slab will occur at the sides of this rectangle. While these assumptions are empirical they are considered conservative since for the sake of simplicity in the calculations various other factors are omitted which if considered would materially add to the strength of the slab.

The determing bending moment will occur on that side of the enclosing rectangle for which the overhang "e" or "f" is greatest. In the following calculation a section of the slab is considered which is one inch in width and "t" inches in depth.

The square of the required slab thickness "t" is obtained as given below:—

M = Moment for 1″ width of slab $= U \times e \times \frac{e}{2} = \frac{U \times e^2}{2}$ or $\frac{U \times f^2}{2}$ ....(1)

S = Sec. Mod. for 1″ width of slab $= \frac{M}{18000} = \frac{U \times e^2}{36000}$ or $\frac{U \times f^2}{36000}$ ....(2)

Since $S = t^2 \div 6 \;\therefore\; t^2 = \frac{U \times e^2}{6000}$ or $\frac{U \times f^2}{6000}$ ....(3)

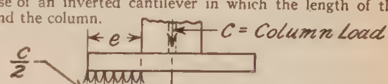
Having the value of t^2, the required slab may be selected from table III, which is arranged to show the value of t^2 for usual available thicknesses.

Slabs 4″ and less in thickness can be straightened and do not require planing. For slabs over 4″ there has been deducted ¼″ for planing under the column and also ⅜″ for planing the bottom surface when required.

EXPLANATION OF STRESS FORMULAE

Slabs:—The stresses on the slab are considered as those of an inverted cantilever in which the length of the cantilever is the amount of the projection of the slab beyond the column.

Max. Moment $= \frac{C}{2} \times \frac{e}{2}$



Grillage:—The stresses on the grillage beams are considered as those of a simple beam, and the Max. Moment therefore occurs at the center.

$$\text{Max. Moment} = \frac{C}{2} \times \frac{l}{4} - \frac{C}{2} \times \frac{L}{4} = \frac{C}{2}\left(\frac{l-L}{4}\right) = \frac{C\,(l-L)}{8}$$

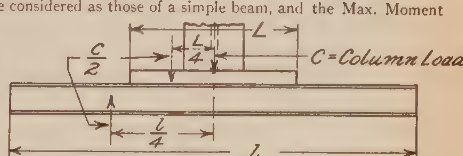
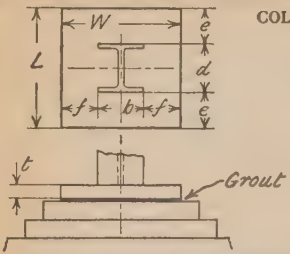


TABLE III

VALUES FOR t^2 FOR VARIOUS THICKNESSES

t^2	Slab thickness			t^2	Slab thickness		
	Rough	Machine faced			Rough	Machine faced	
		Top only	Top & Bottom			Top only	Top & Bottom
6.25	2½			39.06	6½	6¼	
9.00	3			40.64	7		6⅜
12.25	3½			45.56	7	6¾	
16.00	4			54.39	8		7⅜
15.02	4½		3⅞	60.06	8	7¾	
18.06	4½	4¼		70.14	9		8⅜
19.14	5		4⅜	76.56	9	8¾	
22.56	5	4¾		87.89	10		9⅜
23.77	5½		4⅞	95.06	10	9¾	
27.56	5½	5¼		107.64	11		10⅜
28.90	6		5⅜	115.56	11	10¾	
33.06	6	5¾		129.39	12		11⅜
34.51	6½		5⅞	138.06	12	11¾	

SOLID STEEL SLABS FOR COLUMN BASES



COLUMN BASE RESTING UPON MASONRY

C = Total Load on Column in pounds
L = Length of Slab in inches
W = Width of Slab in inches
t = Thickness of Slab in inches
U = Allowable Unit Pressure on Masonry (Table II)
A = Area of the Slab base in square inches = C ÷ U

The area of the slab base must first be computed from the Unit Pressure allowed on the type of Masonry to be used for the foundation and the Load on the Column. A = C ÷ U

Select a slab having a rolled width of one of the dimensions L or W (see Table I). The thickness of the slab is then computed as shown on the preceding page.

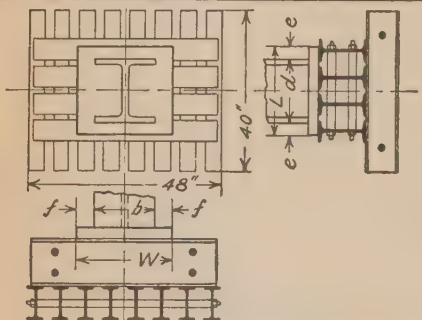
Slab bases resting on masonry need not be machine faced on the bottom but should be grouted.

Example: –

Column Load = 960000# ; Column dimensions, d = 15.75″ and b = 15.25″; Unit Pressure on Masonry, U = 600
Then A = 960000 ÷ 600 = 1600 sq. inches = 40″ × 40″ Slab base

Then $e = \frac{40-15.75}{2} = 12.125$ and $f = \frac{40-15.25}{2} = 12.375 \quad \therefore t^2 = 600 \times 12.375 \times 12.375 \div 6000 = 15.31$

This value of t^2 requires a slab 4½″ thick machine faced on top. (Table III)



COLUMN BASE RESTING UPON GRILLAGE

C = Total Load on Column in pounds
L = Length of Slab in inches
W = Width of Slab in inches
t = Thickness of Slab in inches
U = Allowable Unit Pressure on Masonry (Table II)
A = Area of the Slab base in square inches = C ÷ U

The area of the grillage is determined by the Unit pressure allowed on the type of Masonry to be used for the foundation, and the shape is often determined by the building conditions.

Select a slab having a rolled width of one of the dimensions L or W. (See Table I). W should not be less than 30% of the length of the grillage and L must extend at least ¾″ beyond the center lines of the outside grillage beams. The thickness of the slab is computed as shown on the preceding page.

Slab bases resting on grillage must be true and flat and if over 4″ thick must be machine faced on top and bottom.

Upper tier grillage beams should be spaced with 1″ minimum clear distance between the flanges. Lower tier beams should have 2″ minimum clearance and a maximum of ¾ of the flange width.

Example:—

Column Load = 960000# ; Column dimensions, d = 15.75″ and b = 15.25″; Size of Grillage = 4′ - 0″ × 3′ - 4″
Grillage = 48″ × 40″ = 1920 sq. inches. Therefore:— Unit pressure on masonry foundation = 500# per sq. inch.
Column base:— W = 24″ and L = 22″. Then A = 528 sq. inches and U = C ÷ A = 1818

Then $e = \frac{22-15.75}{2} = 3.125$ and $f = \frac{24-15.25}{2} = 4.375 \quad \therefore t^2 = \frac{1818}{6000} \times \frac{4.375}{1} \times \frac{4.375}{1} = 5.80$

This requires use of a slab 2½″ thick (Table III)

Upper tier grillage beams

Max. Bending Moment $= \frac{960000\,(48-24)}{8} = 2880000$″#

4-I^s 12″-45# good for 852300″# each = 3409200″#

Max. Shear $= \frac{960000}{48} \times \frac{(48-24)}{2} = 240000$ #

4-I^s 12″-45# good for 81400# each = 325600 #

*Web Buckling. Total Load = 960000 #

I^s 12″-45# good for 8475# per inch of web + 8475 x d/2

4-I^s 12″-45# good for $4 \times 8475 \times \left(24 + \frac{12}{2}\right) = 1017000$#

Lower tier grillage beams

Max. Bending Moment $= \frac{960000(40-25.235)}{8} = 1771800$″#

†8-I^s 8″-20.5# good for 270900″# each = 2167200″#

Max. Shear $= \frac{960000}{40} \times \frac{40-25.235}{2} = 177180$ #

†8-I^s 8″-20.5# good for 33500# each = 268000 #

*Web Buckling. Total Load = 960000 #

I^s 8″-20.5# good for 5235# per inch of web + 5235 × d/2

†8-I^s 8″-20.5# good for $8 \times 5235 \times \left(25.235 + \frac{8}{2}\right) = 1224360$#

*See table of end reactions and notes below.
†Seven beams have the required strength. Eight are necessary due to the limit allowed for space between flanges.

Part IV
Section 14

Rivets

Values in Plates

Values in Channel and Beam Webs

Dimensions, Weights, and Signs

Riveting Details

Lengths for various Grips

Reduction of Area in Plates

Bolts

Dimensions and Weights

SHEAR @ 13500	WORKING VALUES FOR POWER DRIVEN RIVETS AND TURNED BOLTS IN REAMED HOLES	BEARING Single @ 24000 Double @ 30000

Rivet dia.	½″		⅝″		¾″		⅞″		1″		1⅛″		1¼″	
Area	.1963		.3068		.4418		.6013		.7854		.9940		1.2272	
Single Sh.	2650		4140		5960		8120		10600		13420		16570	
Double Sh.	5300		8280		11930		16240		21200		26840		33130	
Thickness of Plate	Bearing		Bearing		Bearing		Bearing		Bearing		Bearing		Bearing	
	24000	30000	24000	30000	24000	30000	24000	30000	24000	30000	24000	30000	24000	30000
.170	2040	2550	2550	3190	3060	3830	3570	4460	4080	5100	4590	5740	5100	6380
.180	2160	2700	2700	3380	3240	4050	3780	4730	4320	5400	4860	6080	5400	6750
.1875 3/16	2250	2810	2810	3520	3380	4220	3940	4920	4500	5630	5060	6330	5630	7030
.190	2280	2850	2850	3560	3420	4280	3990	4990	4560	5700	5130	6410	5700	7130
.200	2400	3000	3000	3750	3600	4500	4200	5250	4800	6000	5400	6750	6000	7500
.210	2520	3150	3150	3940	3780	4730	4410	5510	5040	6300	5670	7090	6300	7880
.220	2640	3300	3300	4130	3960	4950	4620	5780	5280	6600	5940	7430	6600	8250
.230	....	3450	3450	4310	4140	5180	4830	6040	5520	6900	6210	7760	6900	8630
.240	....	3600	3600	4500	4320	5400	5040	6300	5760	7200	6480	8100	7200	9000
.250 ¼	....	3750	3750	4690	4500	5630	5250	6560	6000	7500	6750	8440	7500	9380
.260	....	3900	3900	4880	4680	5850	5460	6830	6240	7800	7020	8780	7800	9750
.270	....	4050	4050	5060	4860	6080	5670	7090	6480	8100	7290	9110	8100	10130
.280	....	4200	....	5250	5040	6300	5880	7350	6720	8400	7560	9450	8400	10500
.290	....	4350	....	5440	5220	6530	6090	7610	6960	8700	7830	9790	8700	10880
.300	....	4500	....	5630	5400	6750	6300	7880	7200	9000	8100	10130	9000	11250
.310	....	4650	....	5810	5580	6980	6510	8140	7440	9300	8370	10460	9300	11630
.312. 5/16	....	4690	....	5860	5630	7030	6560	8200	7500	9380	8440	10550	9380	11720
.320	....	4800	....	6000	5760	7200	6720	8400	7680	9600	8640	10800	9600	12000
.330	....	4950	....	6190	5940	7430	6930	8660	7920	9900	8910	11140	9900	12380
.340	....	5100	....	6380	5960	7650	7140	8930	8160	10200	9180	11480	10200	12750
.350	....	5250	....	6560	....	7880	7350	9190	8400	10500	9450	11810	10500	13130
.360	....	....	....	6750	....	8100	7560	9450	8640	10800	9720	12150	10800	13500
.370	....	....	....	6940	....	8330	7770	9710	8880	11100	9990	12490	11100	13880
.375 ⅜	....	....	....	7030	....	8440	7880	9840	9000	11250	10130	12660	11250	14050
.380	....	....	....	7130	....	8550	7980	9980	9120	11400	10260	12830	11400	14250
.390	....	....	....	7310	....	8780	....	10240	9360	11700	10530	13160	11700	14630
.400	....	....	....	7500	....	9000	....	10500	9600	12000	10800	13500	12000	15000
.410	....	....	....	7690	....	9230	....	10760	9840	12300	11070	13840	12300	15380
.420	....	....	....	7880	....	9450	....	11030	10080	12600	11340	14180	12600	15750
.430	....	....	....	8060	....	9680	....	11290	10320	12900	11610	14510	12900	16130
.4375 7/16	....	....	....	8200	....	9840	....	11480	10500	13130	11810	14770	13130	16410
.440	....	....	....	8250	....	9900	....	11550	10560	13200	11880	14850	13200	16500
.450	....	....	....	....	....	10130	....	11810	....	13500	12150	15190	13500	16880
.460	....	....	....	....	....	10350	....	12080	....	13800	12420	15530	13800	17250
.470	....	....	....	....	....	10580	....	12340	....	14100	12690	15860	14100	17630
.480	....	....	....	....	....	10800	....	12600	....	14400	12960	16200	14400	18000
.490	....	....	....	....	....	11030	....	12860	....	14700	13230	16540	14700	18380
.500 ½	....	....	....	....	....	11250	....	13130	....	15000	....	16880	15000	18750
.510	....	....	....	....	....	11480	....	13390	....	15300	....	17210	15300	19130
.520	....	....	....	....	....	11700	....	13650	....	15600	....	17550	15600	19500
.530	....	....	....	....	....	11930	....	13910	....	15900	....	17890	15900	19880
.540	....	....	....	....	....	11930	....	14180	....	16200	....	18230	16200	20250
.550	....	....	....	....	....	....	....	14440	....	16500	....	18560	16500	20630
.560	....	....	....	....	....	....	....	14700	....	16800	....	18900	....	21000
.5625 9/16	....	....	....	....	....	....	....	14770	....	16880	....	18980	....	21090
.570	....	....	....	....	....	....	....	14960	....	17100	....	19240	....	21380
.580	....	....	....	....	....	....	....	15230	....	17400	....	19580	....	21750
.590	....	....	....	....	....	....	....	15490	....	17700	....	19910	....	22130
.600	....	....	....	....	....	....	....	15750	....	18000	....	20250	....	22500
.610	....	....	....	....	....	....	....	16010	....	18300	....	20590	....	22880
.620	....	....	....	....	....	....	....	....	....	18600	....	20930	....	23250
.625 ⅝	....	....	....	....	....	....	....	....	....	18750	....	21090	....	23440
.630	....	....	....	....	....	....	....	....	....	18900	....	21260	....	23630
.640	....	....	....	....	....	....	....	....	....	19200	....	21600	....	24000
.650	....	....	....	....	....	....	....	....	....	19500	....	21940	....	24380
.660	....	....	....	....	....	....	....	....	....	19800	....	22280	....	24750
.670	....	....	....	....	....	....	....	....	....	20100	....	22610	....	25130
.680	....	....	....	....	....	....	....	....	....	20400	....	22950	....	25500
.687 11/16	....	....	....	....	....	....	....	....	....	20630	....	23200	....	25780
.690	....	....	....	....	....	....	....	....	....	20700	....	23290	....	25880
.700	....	....	....	....	....	....	....	....	....	21000	....	23630	....	26250
.710	....	....	....	....	....	....	....	....	....	....	....	23960	....	26630
.720	....	....	....	....	....	....	....	....	....	....	....	24300	....	27000
.730	....	....	....	....	....	....	....	....	....	....	....	24640	....	27380
.740	....	....	....	....	....	....	....	....	....	....	....	24980	....	27750
.750 ¾	....	....	....	....	....	....	....	....	....	....	....	25310	....	28130
.812 13/16	....	....	....	....	....	....	....	....	....	....	....	....	....	30470
.875 ⅞	....	....	....	....	....	....	....	....	....	....	....	....	....	32810
.937 15/16	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1.00 1″	12000	15000	15000	18750	18000	22500	21000	26250	24000	30000	27000	33750	30000	37500

LOADS BY A. I. S. C. SPECIFICATION

SHEAR @ 10000	WORKING VALUES FOR HAND DRIVEN RIVETS AND UNFINISHED BOLTS	BEARING Single @ 16000 Double @ 20000

Rivet dia.	½″		⅝″		¾″		⅞″		1″		1⅛″		1¼″	
Area	.1963		.3068		.4418		.6013		.7854		.9940		1.2272	
Single Sh.	1960		3070		4420		6010		7850		9940		12270	
Double Sh.	3930		6140		8840		12030		15710		19880		24540	
Thickness	Bearing		Bearing		Bearing		Bearing		Bearing		Bearing		Bearing	
of Plate	16000	20000	16000	20000	16000	20000	16000	20000	16000	20000	16000	20000	16000	20000
.170	1360	1700	1700	2130	2040	2550	2380	2980	2720	3400	3060	3830	3400	4250
.180	1440	1800	1800	2250	2160	2700	2520	3150	2880	3600	3240	4050	3600	4500
.1875 3/16	1500	1880	1880	2340	2250	2810	2630	3280	3000	3750	3380	4220	3750	4690
.190	1520	1900	1900	2380	2280	2850	2660	3330	3040	3800	3420	4280	3800	4750
.200	1600	2000	2000	2500	2400	3000	2800	3500	3200	4000	3600	4500	4000	5000
.210	1680	2100	2100	2630	2520	3150	2940	3680	3360	4200	3780	4730	4200	5250
.220	1760	2200	2200	2750	2640	3300	3080	3850	3520	4400	3960	4950	4400	5500
.230	1840	2300	2300	2880	2760	3450	3220	4030	3680	4600	4140	5180	4600	5750
.240	1920	2400	2400	3000	2880	3600	3360	4200	3840	4800	4320	5400	4800	6000
.250 ¼	....	2500	2500	3130	3000	3750	3500	4380	4000	5000	4500	5630	5000	6250
.260	....	2600	2600	3250	3120	3900	3640	4550	4160	5200	4680	5850	5200	6500
.270	....	2700	2700	3380	3240	4050	3780	4730	4320	5400	4860	6080	5400	6750
.280	....	2800	2800	3500	3360	4200	3920	4900	4480	5600	5040	6300	5600	7000
.290	....	2900	2900	3630	3480	4350	4060	5080	4640	5800	5220	6530	5800	7250
.300	....	3000	3000	3750	3600	4500	4200	5250	4800	6000	5400	6750	6000	7500
.310	....	3100	....	3880	3720	4650	4340	5430	4960	6200	5580	6980	6200	7750
.3125 5/16	....	3130	....	3910	3750	4690	4380	5470	5000	6250	5630	7030	6250	7810
.320	....	3200	....	4000	3840	4800	4480	5600	5120	6400	5760	7200	6400	8000
.330	....	3300	....	4130	3960	4950	4620	5780	5280	6600	5940	7430	6600	8250
.340	....	3400	....	4250	4080	5100	4760	5950	5440	6800	6120	7650	6800	8500
.350	....	3500	....	4380	4200	5250	4900	6130	5600	7000	6300	7880	7000	8750
.360	....	3600	....	4500	4320	5400	5040	6300	5760	7200	6480	8100	7200	9000
.370	....	3700	....	4630	....	5550	5180	6480	5920	7400	6660	8330	7400	9250
.375 ⅜	....	3750	....	4690	....	5630	5250	6560	6000	7500	6750	8440	7500	9370
.380	....	3800	....	4750	....	5700	5320	6650	6080	7600	6840	8550	7600	9500
.390	....	3900	....	4880	....	5850	5460	6830	6240	7800	7020	8780	7800	9750
.400	....	....	....	5000	....	6000	5600	7000	6400	8000	7200	9000	8000	10000
.410	....	....	....	5130	....	6150	5740	7180	6560	8200	7380	9230	8200	10250
.420	....	....	....	5250	....	6300	5880	7350	6720	8400	7560	9450	8400	10500
.430	....	....	....	5380	....	6450	....	7530	6880	8600	7740	9680	8600	10750
.4375 7/16	....	....	....	5470	....	6560	....	7660	7000	8750	7880	9840	8750	10940
.440	....	....	....	5500	....	6600	....	7700	7040	8800	7920	9900	8800	11000
.450	....	....	....	5630	....	6750	....	7880	7200	9000	8100	10130	9000	11250
.460	....	....	....	5750	....	6900	....	8050	7360	9200	8280	10350	9200	11500
.470	....	....	....	5880	....	7050	....	8230	7520	9400	8460	10580	9400	11750
.480	....	....	....	6000	....	7200	....	8400	7680	9600	8640	10800	9600	12000
.490	....	....	....	6130	....	7350	....	8580	7840	9800	8820	11030	9800	12250
.500 ½	....	....	....	....	....	7500	....	8750	....	10000	9000	11250	10000	12500
.510	....	....	....	....	....	7650	....	8930	....	10200	9180	11480	10200	12750
.520	....	....	....	....	....	7800	....	9100	....	10400	9360	11700	10400	13000
.530	....	....	....	....	....	7950	....	9280	....	10600	9540	11930	10600	13250
.540	....	....	....	....	....	8100	....	9450	....	10800	9720	12150	10800	13500
.550	....	....	....	....	....	8250	....	9630	....	11000	9900	12380	11000	13750
.560	....	....	....	....	....	8400	....	9800	....	11200	....	12600	11200	14000
.5625 9/16	....	....	....	....	....	8440	....	9850	....	11250	....	12660	11250	14060
.570	....	....	....	....	....	8550	....	9980	....	11400	....	12830	11400	14250
.580	....	....	....	....	....	8700	....	10150	....	11600	....	13050	11600	14500
.590	....	....	....	....	....	....	....	10330	....	11800	....	13280	11800	14750
.600	....	....	....	....	....	....	....	10500	....	12000	....	13500	12000	15000
.610	....	....	....	....	....	....	....	10680	....	12200	....	13730	12200	15250
.620	....	....	....	....	....	....	....	10850	....	12400	....	13950	....	15500
.625 ⅝	....	....	....	....	....	....	....	10940	....	12500	....	14060	....	15630
.630	....	....	....	....	....	....	....	11030	....	12600	....	14180	....	15750
.640	....	....	....	....	....	....	....	11200	....	12800	....	14400	....	16000
.650	....	....	....	....	....	....	....	11380	....	13000	....	14630	....	16250
.660	....	....	....	....	....	....	....	11550	....	13200	....	14850	....	16500
.670	....	....	....	....	....	....	....	11730	....	13400	....	15080	....	16750
.680	....	....	....	....	....	....	....	11900	....	13600	....	15300	....	17000
.687 11/16	....	....	....	....	....	....	....	12030	....	13750	....	15470	....	17190
.690	....	....	....	....	....	....	....	....	....	13800	....	15530	....	17250
.700	....	....	....	....	....	....	....	....	....	14000	....	15750	....	17500
.710	....	....	....	....	....	....	....	....	....	14200	....	15980	....	17750
.720	....	....	....	....	....	....	....	....	....	14400	....	16200	....	18000
.730	....	....	....	....	....	....	....	....	....	14600	....	16430	....	18250
.740	....	....	....	....	....	....	....	....	....	14800	....	16650	....	18500
.750 ¾	....	....	....	....	....	....	....	....	....	15000	....	16880	....	18750
.812 13/16	....	....	....	....	....	....	....	....	....	....	....	18280	....	20310
.875 ⅞	....	....	....	....	....	....	....	....	....	....	....	19690	....	21870
.937 15/16	....	....	....	....	....	....	....	....	....	....	....	....	....	23440
1.00 1″	8000	10000	10000	12500	12000	15000	14000	17500	16000	20000	18000	22500	20000	25000

LOADS BY A. I. S. C. SPECIFICATION

WORKING VALUES FOR ONE ¾″ POWER DRIVEN RIVET OR TURNED BOLT IN REAMED HOLE IN CHANNEL AND BEAM WEBS

Shear @ 13500 | Single Shear Bearing @ 24000 | Double Shear Bearing @ 30000

Depth in Inches	Amer. Std. Channels			Amer. Std. Beams			Bethlehem Beams			Beth. Girder Beams			Carnegie Beam Sect.		
	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear
3	4.1	3060	3830	5.7	3060	3830									
	5.0	4640	5810	6.5	4520	5650									
	6.0	5960	8010	7.5	5960	7850									
4	5.4	3240	4050	7.7	3420	4280									
	6.25	4440	5560	8.5	4550	5690									
	7.25	5760	7200	9.5	5870	7340									
				10.5	5960	9000									
5	6.7	3420	4280	10.0	3780	4730									
	9.0	5850	7310	12.25	5960	7810									
	11.5	5960	10620	14.75	5960	11120									
6	8.2	3600	4500	12.5	4140	5180									
	10.5	5650	7070	14.75	5960	7720									
	13.0	5960	9830	17.25	5960	10460									
	15.5	5960	11930												
7	9.8	3780	4730	15.3	4500	5630									
	12.25	5650	7070	17.5	5960	7760									
	14.75	5960	9430	20.0	5960	10130									
	17.25	5960	11790												
	19.75	5960	11930												
8	11.50	3960	4950	18.4	4860	6080	17.5	4500	5630	29.5	5130	6410	24.0	4300	5380
	13.75	5450	6820	20.5	5960	7850	19.0	4860	6080	33.0	5220	6530	27.0	4820	6030
	16.25	5960	8890	23.0	5960	9920				36.5	5580	6980	30.0	5364	6710
	18.75	5960	10960	25.5	5960	11930							31.0	5220	6530
	21.25	5960	11930										36.0	5960	7560
													42.0	5960	8780
9	13.40	4140	5180	21.8	5220	6530	20.5	4500	5630	36.0	5220	6530	29.0	5020	6280
	15.0	5130	6410	25.0	5960	8930	22.0	4680	5850	38.5	5580	6980	32.0	5530	6910
	20.0	5960	10080	30.0	5960	11930				43.5	5960	7880	35.0	5960	7540
	25.0	5960	11930	35.0	5960	11930							38.0	5690	7110
													43.0	5960	8030
													48.0	5960	8960
10	15.3	4320	5400	25.4	5580	6980	21.0	4320	5400	41.5	5580	6980	21.0	4140	5180
	20.0	5960	8530	30.0	5960	10060	23.5	4500	5630	44.5	5760	7200	23.0	4140	5180
	25.0	5960	11840	35.0	5960	11930	26.0	4860	6080	50.0	5960	8100	26.0	4660	5830
	30.0	5960	11930	40.0	5960	11930	28.5	5130	6410				30.0	5364	6710
	35.0	5960	11930										31.0	5760	7200
													36.0	5960	10510
													42.0	5960	11930
													49.0	5960	8440
													56.0	5960	11930
													63.0	5960	11930
12	20.7	5040	6300	31.8	5960	7880	25.0	4320	5400	51.5	5960	8100	25.0	4320	5400
	25.0	5960	8710	35.0	5960	9630	28.0	4410	5510	55.5	5960	8550	28.0	4320	5400
	30.0	5960	11480	40.8	5960	10350	31.5	4860	6080	61.0	5960	9230	32.0	4930	6170
	35.0	5960	11930	45.0	5960	11930	36.0	5400	6750	66.0	5960	10130	34.0	5960	8440
	40.0	5960	11930	50.0	5960	11930	40.0	5940	7430	70.5	5960	10580	36.0	5540	6930
				55.0	5960	11930	44.0	5960	8100	76.5	5960	11480	40.0	5220	6530
							48.5	5960	8890				45.0	5870	7340
													50.0	6500	8120
													55.0	5960	8440
													60.0	5960	11180
													65.0	5960	11930
													70.0	5960	11930
													75.0	5960	10940
													83.0	5960	11930
													91.0	5960	11930
													100.0	5960	11930

WORKING VALUES FOR ONE 3/4" HAND DRIVEN RIVET OR UNFINISHED BOLT IN CHANNEL AND BEAM WEBS

Shear @ 10000 Single Shear Bearing @ 16000 Double Shear Bearing @ 20000

Depth in Inches	Amer. Std. Channels			Amer. Std. Beams			Bethlehem Beams			Beth. Girder Beams			Carnegie Beam Sect.		
	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear
3	4.1	2040	2550	5.7	2040	2550									
	5.0	3100	3870	6.5	3010	3770									
	6.0	4270	5340	7.5	4190	5240									
4	5.4	2160	2700	7.7	2280	2850									
	6.25	2960	3710	8.5	3040	3800									
	7.25	3840	4800	9.5	3910	4890									
				10.5	4420	6000									
5	6.7	2280	2850	10.0	2520	3150									
	9.0	3900	4880	12.25	4160	5210									
	11.5	4420	7080	14.75	4420	7410									
6	8.2	2400	3000	12.5	2760	3450									
	10.5	3770	4710	14.75	4120	5150									
	13.0	4420	6560	17.25	4420	6980									
	15.5	4420	8390												
7	9.8	2520	3150	15.3	3000	3750									
	12.25	3770	4710	17.5	4140	5180									
	14.75	4420	6290	20.0	4420	6750									
	17.25	4420	7860												
	19.75	4420	8840												
8	11.50	2640	3300	18.4	3240	4050	17.5	3000	3750	29.5	3420	4280	24.0	2870	3590
	13.75	3640	4550	20.5	4190	5240	19.0	3240	4050	33.0	3480	4350	27.0	3220	4020
	16.25	4420	5930	23.0	4420	6620				36.5	3720	4650	30.0	3580	4470
	18.75	4420	7310	25.5	4420	7980							31.0	3480	4350
	21.25	4420	8690										36.0	4032	5040
													42.0	4420	5850
9	13.40	2760	3450	21.8	3480	4350	20.5	3000	3750	36.0	3480	4350	29.0	3350	4190
	15.0	3420	4280	25.0	4420	5960	22.0	3120	3900	38.5	3720	4650	32.0	3680	4610
	20.0	4420	6720	30.0	4420	8420				43.5	4200	5250	35.0	4020	5030
	25.0	4420	8840	35.0	4420	8840							38.0	3790	4740
													43.0	4280	5360
													48.0	4420	5970
10	15.3	2880	3600	25.4	3720	4650	21.0	2880	3600	41.5	3720	4650	21.0	2760	3450
	20.0	4420	5690	30.0	4420	6710	23.5	3000	3750	44.5	3840	4800	23.0	2760	3450
	25.0	4420	7890	35.0	4420	8840	26.0	3240	4050	50.0	4320	5400	26.0	3110	3890
	30.0	4420	8840	40.0	4420	8840	28.5	3420	4280				30.0	3580	4470
	35.0	4420	8840										31.0	3840	4800
													36.0	4420	7010
													42.0	4420	8840
													49.0	4420	5630
													56.0	4420	8720
													63.0	4420	8840
12	20.7	3360	4200	31.8	4200	5250	25.0	2880	3600	51.5	4320	5400	25.0	2880	3600
	25.0	4420	5810	35.0	4420	6420	28.0	2940	3680	55.5	4420	5700	28.0	2880	3600
	30.0	4420	7650	40.8	4420	6900	31.5	3240	4050	61.0	4420	6150	32.0	3290	4110
	35.0	4420	8840	45.0	4420	8480	36.0	3600	4500	66.0	4420	6750	34.0	4420	5630
	40.0	4420	8840	50.0	4420	8840	40.0	3960	4950	70.5	4420	7050	36.0	3700	4620
				55.0	4420	8840	44.0	4320	5400	76.5	4420	7650	40.0	3480	4350
							48.5	4420	5930				45.0	3910	4890
													50.0	4330	5420
													55.0	4420	5630
													60.0	4420	7460
													65.0	4420	8840
													70.0	4420	8840
													75.0	4420	7290
													83.0	4420	8840
													91.0	4420	8840
													100.0	4420	8840

WORKING VALUES FOR ONE 3/4″ POWER DRIVEN RIVET OR TURNED BOLT IN REAMED HOLE IN CHANNEL AND BEAM WEBS

Shear @ 13500 | Single Shear Bearing @ 24000 | Double Shear Bearing @ 30000

Depth in Inches	Amer. Std. Channels			Amer. Std. Beams			Bethlehem Beams			Beth. Girder Beams			Carnegie Beam Sect.		
	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear
14							30.0	4770	5960				30.0	4860	6080
							33.0	4770	5960				33.0	4860	6080
							37.5	5490	6860				36.0	5290	6620
							42.0	5960	7650				38.0	5960	8440
													39.0	5720	7160
													42.0	5960	7700
													48.0	5960	7720
													53.0	5960	8510
													58.0	5960	9290
													61.0	5960	8600
													68.0	5960	9560
													75.0	5960	10530
													85.0	5960	9790
													95.0	5960	10910
													105.0	5960	11930
15	33.9	5960	9000	42.9	5960	9230	36.0	5040	6300	64.5	5960	8780			
	35.0	5960	9500	45.0	5960	10170	38.5	5220	6530	69.0	5960	9450			
	40.0	5960	11700	50.0	5960	11930	40.0	5490	6860	74.0	5960	9900			
	45.0	5960	11930	55.0	5960	11930	42.5	5850	7310	80.5	5960	10800			
	50.0	5960	11930	60.8	5960	11930	46.0	5960	8210	94.0	5960	11930			
	55.0	5960	11930	65.0	5960	11930	50.5	5960	8660	99.0	5960	11930			
				70.0	5960	11930	54.5	5960	9230	105.0	5960	11930			
				75.0	5960	11930	59.5	5960	10130	111.0	5960	11930			
							71.5	5960	11700	127.0	5960	11930			
										135.0	5960	11930			
										141.0	5960	11930			
										147.0	5960	11930			
16							35.0	5130	6410	74.5	5960	8780	35.0	5220	6530
							40.0	5310	6640	81.0	5960	9450	38.0	5650	7070
							45.0	5940	7425	87.0	5960	10130	40.0	5220	6530
							50.0	6059	8210	94.0	5960	10910	43.0	5960	8440
							56.5	5960	8440				45.0	5870	7340
							60.5	5960	8780				50.0	5960	8150
							66.0	5960	9450				58.0	5960	8440
							71.5	5960	10240				63.0	5960	9140
													68.0	5960	9860
													76.0	5960	9430
													83.0	5960	10310
													90.0	5960	11140
													100.0	5960	10440
													107.0	5960	11160
													115.0	5960	11930
18				54.7	5960	10350	47.0	5850	7310	80.0	5960	9450	47.0	5760	7200
				60.0	5960	11930	49.0	5940	7430	86.0	5960	9900	51.0	5960	8440
				65.0	5960	11930	52.0	5960	7990	92.0	5960	10350	52.0	5960	7970
				70.0	5960	11930	54.5	5960	8330	99.0	5960	10910	58.0	5960	8840
				75.6	5960	11930	59.0	5960	8550				67.0	5960	9140
				80.0	5960	11930	64.5	5960	9000				72.0	5960	9810
				85.0	5960	11930	69.0	5960	9450				78.0	5960	10600
				90.0	5960	11930	74.0	5960	9900				86.0	5960	9650
													93.0	5960	10420
													100.0	5960	11210
20				65.4	5960	11250	56.0	5960	8440	99.0	5960	11480			
				70.0	5960	11930	59.5	5960	8440	107.0	5960	11930			
				75.0	5960	11930	62.0	5960	8780	113.0	5960	11930			
				81.4	5960	11930	64.5	5960	9000	120.0	5960	11930			
				85.0	5960	11930	68.5	5960	9230	127.0	5960	11930			
				90.0	5960	11930	73.0	5960	9680	135.0	5960	11930			
				95.0	5960	11930	78.0	5960	10350	142.0	5960	11930			
				100.0	5960	11930				149.0	5960	11930			

WORKING VALUES FOR ONE ¾″ HAND DRIVEN RIVET OR UNFINISHED BOLT IN CHANNEL AND BEAM WEBS

Shear @ 10000 | Single Shear Bearing @ 16000 | Double Shear Bearing @ 20000

Depth in Inches	Amer. Std. Channels			Amer. Std. Beams			Bethlehem Beams			Beth. Girder Beams			Carnegie Beam Sect.		
	Weight Per Foot	Bearing		Weight Per Foot	Bearing		Weight Per Foot	Bearing		Weight Per Foot	Bearing		Weight Per Foot	Bearing	
		Single Shear	Double Shear		Single Shear	Double Shear		Single Shear	Double Shear		Single Shear	Double Shear		Single Shear	Double Shear
14							30.0	3180	3980				30.0	3240	4050
							33.0	3180	3980				33.0	3240	4050
							37.5	3660	4580				36.0	3530	4410
							42.0	4080	5100				38.0	4420	5630
													39.0	3820	4770
													42.0	4100	5130
													48.0	4120	5150
													53.0	4420	5670
													58.0	4420	6200
													61.0	4420	5730
													68.0	4420	6380
													75.0	4420	7020
													85.0	4420	6530
													95 0	4420	7280
													105.0	4420	8040
15	33.9	4420	6000	42.9	4420	6150	36.0	3360	4200	64.5	4420	5850			
	35.0	4420	6330	45.0	4420	6780	38.5	3480	4350	69.0	4420	6300			
	40.0	4420	7800	50.0	4420	8250	40.0	3660	4580	74.0	4420	6600			
	45.0	4420	8840	55.0	4420	8840	42.5	3900	4880	80.5	4420	7200			
	50.0	4420	8840	60.8	4420	8840	46.0	4380	5480	94.0	4420	8100			
	55.0	4420	8840	65.0	4420	8840	50.5	4420	5780	99.0	4420	8550			
				70.0	4420	8840	54.5	4420	6150	105.0	4420	8840			
				75.0	4420	8840	59.5	4420	7560	111.0	4420	8840			
							71.5	4420	7800	127.0	4420	8840			
										135.0	4420	8840			
										141.0	4420	8840			
										147.0	4420	8840			
16							35.0	3420	4280	74.5	4420	5850	35.0	3480	4350
							40.0	3540	4430	81.0	4420	6300	38.0	3770	4710
							45.0	3960	4950	87.0	4420	6750	40 0	3480	4350
							50.0	4380	5480	94.0	4420	7280	43.0	4420	5630
							56.5	4420	5630				45.0	3910	4890
							60.5	4420	5850				50.0	4340	5430
							66.0	4420	6300				58.0	4420	5630
							71.5	4420	6830				63.0	4420	6090
													68.0	4420	6570
													76.0	4420	6290
													83 0	4420	6870
													90 0	4420	7430
													100 0	4420	6960
													107.0	4420	7440
													115.0	4420	7980
18				54.7	4420	6900	47.0	3900	4880	80 0	4420	6300	47.0	3840	4800
				60.0	4420	8210	49.0	3960	4950	86.0	4420	6600	51 0	4420	5630
				65.0	4420	8840	52.0	4260	5330	92.0	4420	6900	52 0	4250	5310
				70.0	4420	8840	54.5	4420	5550	99.0	4420	7280	58.0	4420	5900
				75.6	4420	8400	59.0	4420	5700				67 0	4420	6090
				80.0	4420	8840	64.5	4420	6000				72 0	4420	6540
				85.0	4420	8840	69.0	4420	6300				78.0	4420	7070
				90.0	4420	8840	74.0	4420	6600				86.0	4420	6440
													93.0	4420	6950
													100.0	4420	7470
20				65.4	4420	7500	56.0	4420	5630	99.0	4420	7650			
				70.0	4420	8510	59.5	4420	5630	107.0	4420	8100			
				75.0	4420	8840	62.0	4420	5850	113.0	4420	8400			
				81.4	4420	8840	64.5	4420	6000	120.0	4420	8840			
				85.0	4420	8840	68.5	4420	6150	127.0	4420	8840			
				90.0	4420	8840	73.0	4420	6450	135.0	4420	8840			
				95 0	4420	8840	78.0	4420	6900	142.0	4420	8840			
				100.0	4420	8840				149.0	4420	8840			

WORKING VALUES FOR ONE ¾″ POWER DRIVEN RIVET OR TURNED BOLT IN REAMED HOLE IN CHANNEL AND BEAM WEBS

Shear @ 13500 | Single Shear Bearing @ 24000 | Double Shear Bearing @ 30000

Depth in Inches	Amer. Std. Channels			Amer. Std. Beams			Bethlehem Beams			Beth. Girder Beams			Carnegie Beam Sect.		
	Weight Per Foot	Bearing		Weight Per Foot	Bearing		Weight Per Foot	Bearing		Weight Per Foot	Bearing		Weight Per Foot	Bearing	
		Single Shear	Double Shear		Single Shear	Double Shear		Single Shear	Double Shear		Single Shear	Double Shear		Single Shear	Double Shear
21													58.0	5960	8100
													60.0	5960	8440
													64.0	5960	8910
													70.0	5960	9740
													80.0	5960	9860
													86.0	5960	10580
													92.0	5960	11300
													104.0	5960	10460
													112.0	5960	11230
													120.0	5960	11930
22							58.0	5960	8100	101.0	5960	10130			
							62.5	5960	8330	108.0	5960	10800			
							67.5	5960	8780	116.0	5960	11480			
							73.0	5960	9340	124.0	5960	11930			
							77.0	5960	9560						
							83.0	5960	10240						
							89.0	5960	10910						
							96.5	5960	11810						
24				79.9	5960	11250	70.0	5960	8890	107.0	5960	10910	70.0	5960	9000
				85.0	5960	11930	73.5	5960	8890	113.0	5960	11250	76.0	5960	9110
				90.0	5960	11930	79.5	5960	9680	120.0	5960	11930	85.0	5960	10170
				95.0	5960	11930	84.5	5960	10350	128.0	5960	11930	94.0	5960	11230
				100.0	5960	11930	90.5	5960	10690	132.0	5960	11930	100.0	5960	10130
				105.9	5960	11930	95.5	5960	11360	140.0	5960	11930	110.0	5960	11120
				110.0	5960	11930	99.5	5960	11810	148.0	5960	11930	120.0	5960	11930
				115.0	5960	11930	104.5	5960	11930				130.0	5960	11930
				120.0	5960	11930							140.0	5960	11930
													150.0	5960	11930
													160.0	5960	11930
26							81.0	5960	9900	138.0	5960	11930			
							85.5	5960	10130	144.0	5960	11930			
							91.0	5960	10580	151.0	5960	11930			
							98.0	5960	11250	160.0	5960	11930			
27													91.0	5960	10370
													101.0	5960	11480
													112.0	5960	11930
													124.0	5960	11930
													137.0	5960	11930
													145.0	5960	11930
													160.0	5960	11930
													175.0	5960	11930
													190.0	5960	11930
28							91.0	5960	10130	145.0	5960	11930			
							97.0	5960	10580	156.0	5960	11930			
							104.0	5960	11250	165.0	5960	11930			
							112.0	5960	11930	175.0	5960	11930			
30							110.0	5960	11700	173.0	5960	11930	115.0	5960	11930
							115.0	5960	11930	180.0	5960	11930	126.0	5960	11930
							121.0	5960	11930	190.0	5960	11930	138.0	5960	11930
							129.0	5960	11930	200.0	5960	11930	151.0	5960	11930
													165.0	5960	11930
													180.0	5960	11930
													200.0	5960	11930
													220.0	5960	11930
													240.0	5960	11930
33							125.0	5960	11930	202.0	5960	11930			
							135.0	5960	11930	210.0	5960	11930			
							143.0	5960	11930	220.0	5960	11930			
							152.0	5960	11930	230.0	5960	11930			
36							147.0	5960	11930	231.0	5960	11930			
							155.0	5960	11930	240.0	5960	11930			
							164.0	5960	11930	250.0	5960	11930			
							173.0	5960	11930	260.0	5960	11930			

WORKING VALUES FOR ONE ¾″ HAND DRIVEN RIVET OR UNFINISHED BOLT IN CHANNEL AND BEAM WEBS

Shear @ 10000 Single Shear Bearing @ 16000 Double Shear Bearing @ 20000

Depth in Inches	Amer. Std. Channels			Amer. Std. Beams			Bethlehem Beams			Beth. Girder Beams			Carnegie Beam Sect.		
	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear	Weight Per Foot	Bearing Single Shear	Bearing Double Shear
21													58.0	4320	5400
													60.0	4420	5630
													64.0	4420	5940
													70.0	4420	6500
													80.0	4420	6570
													86.0	4420	7050
													92.0	4420	7530
													104.0	4420	6980
													112.0	4420	7490
													120.0	4420	8030
22							58.0	4320	5400	101.0	4420	6750			
							62.5	4420	5550	108.0	4420	7200			
							67.5	4420	5850	116.0	4420	7650			
							73.0	4420	6230	124.0	4420	8180			
							77.0	4420	6380						
							83.0	4420	6830						
							89.0	4420	7280						
							96.5	4420	7880						
24				79.9	4420	7500	70.0	4420	5930	107.0	4420	7280	70.0	4420	6000
				85.0	4420	8440	73.5	4420	5930	113.0	4420	7500	76.0	4420	6080
				90.0	4420	8840	79.5	4420	6450	120.0	4420	7950	85.0	4420	6780
				95.0	4420	8840	84.5	4420	6900	128.0	4420	8550	94.0	4420	7490
				100.0	4420	8840	90.5	4420	7130	132.0	4420	7550	100.0	4420	6750
				105.9	4420	8840	95.5	4420	7580	140.0	4420	8840	110.0	4420	7410
				110.0	4420	8840	99.5	4420	7880	148.0	4420	8840	120.0	4420	8090
				115.0	4420	8840	104.5	4420	8250				130.0	4420	8210
				120.0	4420	8840							140.0	4420	8820
													150.0	4420	8840
													160.0	4420	8840
26							81.0	4420	6600	138.0	4420	8700			
							85.5	4420	6750	144.0	4420	8840			
							91.0	4420	7050	151.0	4420	8840			
							98.0	4420	7500	160.0	4420	8840			
27													91.0	4420	6920
													101.0	4420	7650
													112.0	4420	8490
													124.0	4420	8840
													137.0	4420	8840
													145.0	4420	8700
													160.0	4420	8840
													175.0	4420	8840
													190.0	4420	8840
28							91.0	4420	6750	145.0	4420	8780			
							97.0	4420	7050	156.0	4420	8840			
							104.0	4420	7500	165.0	4420	8840			
							112.0	4420	8030	175.0	4420	8840			
30							110.0	4420	7800	173.0	4420	8840	115.0	4420	7950
							115.0	4420	7950	180.0	4420	8840	126.0	4420	8720
							120.0	4420	8250	190.0	4420	8840	138.0	4420	8840
							129.0	4420	8700	200.0	4420	8840	151.0	4420	8840
													165.0	4420	8840
													180.0	4420	8840
													200.0	4420	8840
													220.0	4420	8840
													240.0	4420	8840
33							125.0	4420	8100	202.0	4420	8840			
							135.0	4420	8700	210.0	4420	8840			
							143.0	4420	8840	220.0	4420	8840			
							152.0	4420	8840	230.0	4420	8840			
36							147.0	4420	8840	231.0	4420	8840			
							155.0	4420	8840	240.0	4420	8840			
							164.0	4420	8840	250.0	4420	8840			
							173.0	4420	8840	260.0	4420	8840			

DIMENSIONS, WEIGHTS AND CONVENTIONAL SIGNS FOR RIVETS

DIMENSIONS OF RIVET HEADS (DRIVEN)

FORMULAE

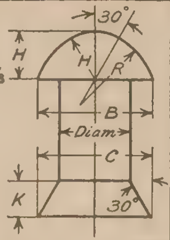
Diam. Head B = 1.5 D + 1/8

Height of Hd. H = .425 B

Long Rad. R = 1.5 H

Short Rad. = H

Depth of Countersink K = .5 D



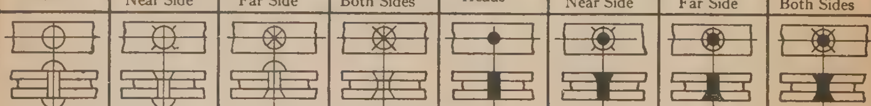
Diam of Rivet	BUTTON HEAD Diam. B	BUTTON HEAD Height H	BUTTON HEAD Radius R	COUNTERSUNK Diam. C	COUNTERSUNK Height K
3/8	11/16	5/16	7/16	9/16	3/16
1/2	7/8	3/8	9/16	3/4	1/4
5/8	1 1/16	7/16	11/16	1	5/16
3/4	1 1/4	1/2	13/16	1 3/16	3/8
7/8	1 7/16	5/8	15/16	1 3/8	7/16
1	1 5/8	11/16	1	1 9/16	1/2
1 1/8	1 13/16	3/4	1 1/8	1 3/4	9/16
1 1/4	2	7/8	1 1/4	2	5/8
1 3/8	2 3/16	15/16	1 3/8	2 3/16	11/16
1 1/2	2 3/8	1	1 1/2	2 3/8	3/4

WEIGHTS OF 100 BUTTON HEAD STEEL RIVETS

Length in Inches under Head	Diameter of Rivets in Inches: 3/8	1/2	5/8	3/4	7/8	1″	1 1/8	1 1/4	1 3/8	1 1/2
1	4.8	10.0	17	28						
1 1/4	5.6	11.4	20	31	44	60				
1 1/2	6.4	12.7	22	34	48	65	87			
1 3/4	7.2	14.1	24	37	52	70	93			
2	7.9	15.5	26	40	56	75	100	133	167	206
2 1/4	8.7	16.9	28	43	60	81	107	141	177	218
2 1/2	9.5	18.3	30	46	64	86	114	149	187	230
2 3/4	10.3	19.7	33	49	69	91	120	158	197	242
3	11.1	21.0	35	52	73	96	127	166	208	254
3 1/4	11.9	22.4	37	55	77	102	134	174	218	266
3 1/2	12.6	23.8	39	58	81	107	141	183	228	278
3 3/4	13.4	25.2	41	62	85	112	148	191	238	290
4	....	26.6	43	65	89	118	154	199	248	302
4 1/4	....	28.0	46	68	93	123	161	208	258	314
4 1/2	....	29.4	48	71	97	128	168	216	268	327
4 3/4	....	30.7	50	74	101	133	175	224	278	339
5	....	32.1	52	77	105	139	181	233	288	351
5 1/4	....	....	54	80	110	144	188	241	298	363
5 1/2	....	....	56	83	114	149	195	249	308	375
5 3/4	....	....	58	86	118	154	201	258	318	387
6	....	....	61	89	122	160	208	266	329	399
6 1/2	....	....	..	95	130	170	222	283	349	423
7	....	....	..	102	138	181	235	300	369	447
7 1/2	....	....	..	108	146	191	249	316	389	471
Weight of 100 Button Heads Only	1.7	4.4	9	15	23	33	46	66	87	110

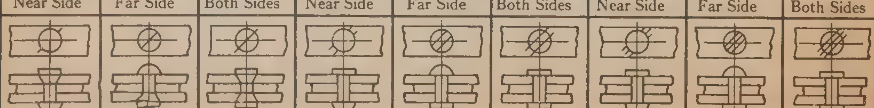
CONVENTIONAL SIGNS FOR RIVETING

SHOP RIVETS: Two Full Heads	SHOP RIVETS: Countersunk and Chipped: Near Side	Far Side	Both Sides	FIELD RIVETS: Two Full Heads	FIELD RIVETS: Countersunk and Chipped: Near Side	Far Side	Both Sides



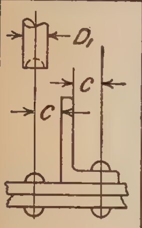
SHOP RIVETS

Countersunk, Not Chipped, 1/8 High: Near Side	Far Side	Both Sides	Flattened, 1/4 High, 1/2 and 5/8 Rivets: Near Side	Far Side	Both Sides	Flattened, 3/8 High, 3/4 to 1″ Rivets: Near Side	Far Side	Both Sides



RIVETING DETAILS

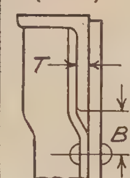
DRIVING CLEARANCE



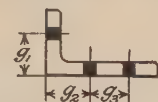
Riv. Diam.	Die D1	Clear C
3/8	1 1/2	7/8
1/2	1 3/4	1
5/8	2	1 1/8
3/4	2 1/4	1 1/4
7/8	2 1/2	1 3/8
1	2 3/4	1 1/2
1 1/8	3	1 5/8
1 1/4	3 1/4	1 3/4
1 3/8	3 1/2	1 7/8
1 1/2	3 3/4	2

CRIMPS

B = T + 1 1/2″
(Min. 2″)

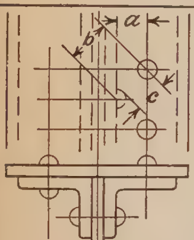


GAGES FOR ANGLES



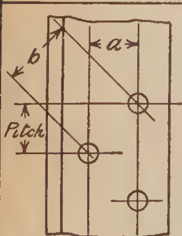
Leg.	1 3/4	2	2 1/2	3	3 1/2	4	5	6	7	8
g1	1	1 1/8	1 3/8	1 3/4	2	2 1/2	3	3 1/2	4	4 1/2
g2	...	...	...	...	...	...	2	2 1/2	2 1/2	3
g3	...	...	...	...	...	...	1 3/4	2 1/4	3	3
Max. Riv	1/2	5/8	3/4	7/8	7/8	7/8	7/8	7/8	1	1 1/8

MINIMUM PITCH FOR MACHINE RIVETING



Riv. Diam. D	Std. c	Std. b	a 1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 3/4
3/8	7/8	1 3/16	1/4	0	...	...	...	...	...	...	...	...	...	...	...
1/2	1	1 3/8	3/4	1/2	0	...	...	...	...	...	...	...	...	...	...
5/8	1 1/8	1 9/16	1 1/8	1	3/4	3/8	0	...	...	...	...	...	...	...	...
3/4	1 1/4	1 3/4	...	1 1/4	1 1/8	1	3/4	0	...	...	...	...	...	...	...
7/8	1 3/8	2	...	...	1 1/2	1 3/8	1 1/8	7/8	5/8	0	...	...	...	...	...
1	1 1/2	2 3/16	...	...	...	1 5/8	1 1/2	1 3/8	1 1/8	7/8	1/2	0	...	...	...
1 1/8	1 5/8	2 3/8	...	...	...	...	1 3/4	1 5/8	1 1/2	1 3/8	1 1/8	7/8	0	...	...
1 1/4	1 3/4	2 5/8	...	...	...	...	...	2	1 7/8	1 3/4	1 1/2	1 1/4	1	5/8	0
1 3/8	1 7/8	2 13/16	...	...	...	...	...	...	2 1/8	2	1 7/8	1 3/4	1 1/2	1 1/4	1/2
1 1/2	2	3	...	...	...	...	...	...	...	2 1/4	2 1/8	2	1 7/8	1 5/8	1 1/8

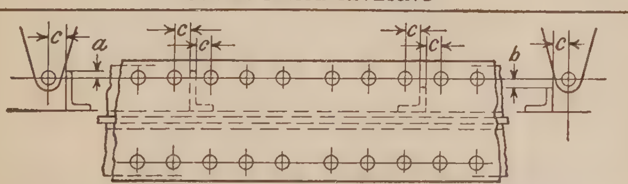
MINIMUM PITCH TO MAINTAIN 3 DIAMETERS C TO C



Riv. Diam. D	Min. CtoC b	a 1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4
3/8	1 1/8	1/2	0	...	...	...	...	...	...	...	...	...	...	...	...
1/2	1 1/2	1 1/8	7/8	0	...	...	...	...	...	...	...	...	...	...	...
5/8	1 7/8	1 5/8	1 3/8	1 1/8	5/8	0	...	...	...	...	...	...	...	...	...
3/4	2 1/4	2	1 7/8	1 5/8	1 3/8	1	0	...	...	...	...	...	...	...	...
7/8	2 5/8	2 1/2	2 3/8	2 1/8	2	1 3/4	1 3/8	3/4	0	...	...	...	...	...	...
1	3	2 7/8	2 3/4	2 5/8	2 1/2	2 1/4	2	1 5/8	1 1/8	0	...	...	...	...	...
1 1/8	3 3/8	3 1/4	3 1/8	3	2 7/8	2 3/4	2 1/2	2 1/4	2	1 1/2	7/8	0	...	...	...
1 1/4	3 3/4	3 5/8	3 1/2	3 3/8	3 3/8	3 1/4	3	2 3/4	2 1/2	2 1/4	1 7/8	1 3/8	0	...	...
1 3/8	4 1/8	4	4	3 7/8	3 3/4	3 5/8	3 1/2	3 1/4	3 1/8	2 7/8	2 1/2	2 1/8	1 3/4	1	0
1 1/2	4 1/2	4 3/8	4 3/8	4 1/4	4 1/8	4	3 7/8	3 3/4	3 1/2	3 3/8	3 1/8	2 7/8	2 1/2	2	1 1/2

COVER PLATE RIVETING

a	c
1/2	2 1/2
1	2 5/8
1 1/2	2 3/4
2	2 3/4
2 1/2	2 7/8
3	2 7/8
3 1/2	3
4	3 1/8
5	3 1/4
6	3 3/8

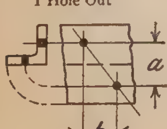


The use of hand pneumatic hammers is avoided where construction permits these clearances.

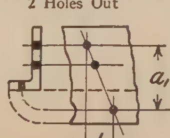
b	c
...	2 1/2
1/2	2 3/8
3/4	2 1/4
1	2 1/4
1 1/4	2 1/8
1 1/2	2
1 3/4	1 3/4
2	1 1/2
2 1/4	1
2 1/2	...

STAGGER OF RIVETS TO MAINTAIN NET SECTION

1 Hole Out



2 Holes Out



5/8″ rivets, can be taken at 1/8″ less than for 3/4″.
1″ rivets, can be taken at 1/8″ more than for 7/8″.

a	3/4 Rivet b	7/8 Rivet b	a1	3/4 Rivet b	7/8 Rivet b
1	1 5/8	1 3/4	5	3 1/16	3 5/16
1 1/2	1 7/8	2	5 1/2	3 1/4	3 1/2
2	2 1/16	2 1/4	6	3 3/8	3 5/8
2 1/2	2 1/4	2 7/16	6 1/2	3 1/2	3 3/4
3	2 7/16	2 5/8	7	3 5/8	3 7/8
3 1/2	2 9/16	2 13/16	7 1/2	3 3/4	4
4	2 13/16	3	8	3 7/8	4 1/8
4 1/2	2 15/16	3 3/16	8 1/2	4	4 1/4

LENGTHS OF UNDRIVEN RIVETS FOR VARIOUS LENGTHS OF GRIP

BUTTON HEAD

Grip	Diameter of Rivet 1/2	5/8	3/4	7/8	1"	1 1/4	1 1/2
1/2	1 5/8	1 3/4	1 7/8	2	2 1/8		
5/8	1 3/4	1 7/8	2	2 1/8	2 1/4		
3/4	1 7/8	2	2 1/8	2 1/4	2 3/8		
7/8	2	2 1/8	2 1/4	2 3/8	2 1/2		
1	2 1/4	2 3/8	2 3/8	2 1/2	2 5/8	2 7/8	3 1/8
1/8	2 3/8	2 1/2	2 1/2	2 5/8	2 3/4	3	3 1/4
1/4	2 1/2	2 5/8	2 5/8	2 3/4	2 7/8	3 1/8	3 3/8
3/8	2 5/8	2 3/4	2 3/4	2 7/8	3	3 1/4	3 1/2
1/2	2 7/8	2 7/8	3	3 1/8	3 1/4	3 3/8	3 5/8
5/8	3	3	3 1/8	3 1/4	3 3/8	3 1/2	3 3/4
3/4	3 1/8	3 1/4	3 1/4	3 1/2	3 1/2	3 5/8	3 7/8
7/8	3 1/4	3 3/8	3 3/8	3 5/8	3 5/8	3 7/8	4
2	3 1/2	3 1/2	3 5/8	3 3/4	3 3/4	4	4 1/4
1/8	3 5/8	3 5/8	3 3/4	3 7/8	3 7/8	4 1/8	4 3/8
1/4	3 3/4	3 7/8	3 7/8	4	4 1/8	4 1/4	4 1/2
3/8	4	4	4	4 1/8	4 1/4	4 3/8	4 5/8
1/2	4 1/8	4 1/8	4 1/8	4 1/4	4 3/8	4 1/2	4 3/4
5/8	4 1/4	4 1/4	4 1/4	4 3/8	4 1/2	4 5/8	4 7/8
3/4	4 3/8	4 3/8	4 3/8	4 1/2	4 5/8	4 3/4	5
7/8	4 5/8	4 5/8	4 5/8	4 5/8	4 3/4	4 7/8	5 1/8
3	...	4 3/4	4 3/4	4 7/8	4 7/8	5 1/8	5 1/4
1/8	...	4 7/8	4 7/8	5	5 1/8	5 1/4	5 3/8
1/4	...	5	5	5 1/8	5 1/4	5 3/8	5 1/2
3/8	...	5 1/8	5 1/8	5 1/4	5 3/8	5 1/2	5 5/8
1/2	...	5 3/8	5 3/8	5 3/8	5 1/2	5 5/8	5 3/4
5/8	...	5 1/2	5 1/2	5 1/2	5 5/8	5 3/4	6
3/4	...	5 5/8	5 5/8	5 5/8	5 3/4	5 7/8	6 1/8
7/8	...	5 3/4	5 3/4	5 3/4	5 7/8	6	6 1/4
4	...	...	5 7/8	6	6	6 1/8	6 3/8
1/8	...	...	6	6 1/8	6 1/4	6 1/4	6 1/2
1/4	...	...	6 1/8	6 1/4	6 3/8	6 3/8	6 5/8
3/8	...	...	6 3/8	6 1/2	6 1/2	6 5/8	6 3/4
1/2	...	...	6 1/2	6 5/8	6 5/8	6 3/4	6 7/8
5/8	...	...	6 5/8	6 3/4	6 3/4	6 7/8	7
3/4	...	...	6 3/4	6 7/8	6 7/8	7	7 1/8
7/8	...	...	6 7/8	7	7	7 1/8	7 1/4
5	...	...	...	7 1/8	7 1/8	7 1/4	7 1/2
1/8	...	...	...	7 1/4	7 1/4	7 3/8	7 5/8
1/4	...	...	...	7 3/8	7 3/8	7 1/2	7 3/4
3/8	...	...	...	7 5/8	7 5/8	7 3/4	7 7/8
1/2	...	...	...	7 3/4	7 3/4	7 7/8	8
5/8	...	...	...	7 7/8	7 7/8	8	8 1/8
3/4	...	...	...	8	8	8 1/8	8 1/4
7/8	...	...	...	8 1/8	8 1/8	8 1/4	8 3/8
6	...	...	...	8 3/8	8 3/8	8 3/8	8 1/2
1/8	...	...	...	8 1/2	8 1/2	8 1/2	8 5/8
1/4	...	...	...	8 5/8	8 5/8	8 5/8	8 3/4
3/8	...	...	...	8 3/4	8 3/4	8 3/4	9
1/2	...	...	...	8 7/8	8 7/8	8 7/8	9 1/8
5/8	...	...	...	9	9	9 1/8	9 1/4
3/4	...	...	...	9 1/8	9 1/8	9 1/4	9 3/8
7/8	...	...	...	9 1/4	9 1/4	9 3/8	9 1/2
7	...	...	...	...	9 3/8	9 1/2	9 5/8
1/8	...	...	...	...	9 5/8	9 5/8	9 3/4
1/4	...	...	...	...	9 3/4	9 3/4	9 7/8
3/8	...	...	...	...	9 7/8	9 7/8	10
1/2	...	...	...	...	10	10	10 1/8
5/8	...	...	...	...	10 1/8	10 1/8	10 1/4
3/4	...	...	...	...	10 1/4	10 3/8	10 1/2
7/8	...	...	...	...	10 3/8	10 1/2	10 5/8

COUNTERSUNK

Grip	Diameter of Rivet 1/2	5/8	3/4	7/8	1"	1 1/4	1 1/2
1/2	1	1	1 1/8	1 1/4	1 1/4		
5/8	1 1/8	1 1/4	1 1/4	1 3/8	1 3/8		
3/4	1 3/8	1 3/8	1 3/8	1 1/2	1 1/2		
7/8	1 1/2	1 1/2	1 1/2	1 5/8	1 5/8		
1	1 5/8	1 5/8	1 5/8	1 3/4	1 3/4	1 7/8	2
1/8	1 3/4	1 3/4	1 7/8	1 7/8	1 7/8	2	2 1/8
1/4	2	2	2	2	2	2 1/8	2 1/4
3/8	2 1/8	2 1/8	2 1/8	2 1/4	2 1/4	2 3/8	2 1/2
1/2	2 1/4	2 1/4	2 1/4	2 3/8	2 3/8	2 1/2	2 5/8
5/8	2 3/8	2 3/8	2 3/8	2 1/2	2 1/2	2 5/8	2 3/4
3/4	2 5/8	2 5/8	2 5/8	2 5/8	2 5/8	2 3/4	2 7/8
7/8	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 7/8	3
2	2 7/8	2 7/8	2 7/8	2 7/8	2 7/8	3	3 1/8
1/8	3 1/8	3	3	3	3	3 1/8	3 1/4
1/4	3 1/4	3 1/8	3 1/8	3 1/8	3 1/4	3 1/4	3 3/8
3/8	3 3/8	3 3/8	3 3/8	3 3/8	3 3/8	3 3/8	3 1/2
1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 5/8	3 5/8
5/8	3 3/4	3 5/8	3 5/8	3 5/8	3 5/8	3 3/4	3 3/4
3/4	3 7/8	3 3/4	3 3/4	3 3/4	3 3/4	3 7/8	4
7/8	4	3 7/8	3 7/8	3 7/8	3 7/8	4	4 1/8
3	...	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/4
1/8	...	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 3/8
1/4	...	4 3/8	4 3/8	4 3/8	4 3/8	4 3/8	4 1/2
3/8	...	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 5/8
1/2	...	4 5/8	4 5/8	4 5/8	4 5/8	4 5/8	4 3/4
5/8	...	4 3/4	4 3/4	4 3/4	4 3/4	4 7/8	4 7/8
3/4	...	5	5	5	5	5	5
7/8	...	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8
4	...	...	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4
1/8	...	...	5 3/8	5 3/8	5 3/8	5 3/8	5 1/2
1/4	...	...	5 1/2	5 1/2	5 1/2	5 1/2	5 5/8
3/8	...	...	5 5/8	5 5/8	5 5/8	5 5/8	5 3/4
1/2	...	...	5 3/4	5 3/4	5 3/4	5 3/4	5 7/8
5/8	...	...	6	6	6	6	6
3/4	...	...	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8
7/8	...	...	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4
5	...	...	...	6 3/8	6 3/8	6 3/8	6 3/8
1/8	...	...	...	6 1/2	6 1/2	6 1/2	6 1/2
1/4	...	...	...	6 5/8	6 5/8	6 5/8	6 5/8
3/8	...	...	...	6 3/4	6 3/4	6 3/4	6 7/8
1/2	...	...	...	6 7/8	6 7/8	6 7/8	7
5/8	...	...	...	7	7	7	7 1/8
3/4	...	...	...	7 1/4	7 1/4	7 1/4	7 1/4
7/8	...	...	...	7 3/8	7 3/8	7 3/8	7 3/8
6	...	...	...	7 1/2	7 1/2	7 1/2	7 1/2
1/8	...	...	...	7 5/8	7 5/8	7 5/8	7 5/8
1/4	...	...	...	7 3/4	7 3/4	7 3/4	7 3/4
3/8	...	...	...	7 7/8	7 7/8	7 7/8	7 7/8
1/2	...	...	...	8	8	8	8
5/8	...	...	...	8 1/4	8 1/4	8 1/4	8 1/4
3/4	...	...	...	8 3/8	8 3/8	8 3/8	8 3/8
7/8	...	...	...	8 1/2	8 1/2	8 1/2	8 1/2
7	...	...	...	...	8 5/8	8 5/8	8 5/8
1/8	...	...	...	...	8 3/4	8 3/4	8 3/4
1/4	...	...	...	...	8 7/8	8 7/8	8 7/8
3/8	...	...	...	...	9	9	9
1/2	...	...	...	...	9 1/8	9 1/8	9 1/8
5/8	...	...	...	...	9 1/4	9 1/4	9 1/4
3/4	...	...	...	...	9 3/8	9 3/8	9 3/8
7/8	...	...	...	...	9 1/2	9 1/2	9 1/2

For 1 1/8" Rivets use lengths given above for 1 1/4", and for 1 3/8" Rivets those given for 1 1/2".

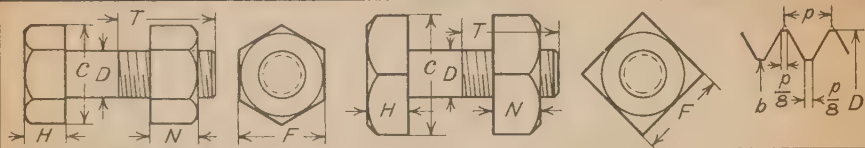
REDUCTION OF AREA IN PLATES FOR RIVET HOLES

Thickness of Plate		DIAMETER OF HOLE IN INCHES															
		1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1"	1 1/16	1 1/8	1 3/16
.170		.043	.053	.064	.074	.085	.096	.106	.117	.128	.138	.149	.159	.170	.181	.191	.202
.180		.045	.056	.068	.079	.090	.101	.113	.124	.135	.146	.158	.169	.180	.191	.203	.214
.1875	3/16	.047	.059	.070	.082	.094	.105	.117	.129	.141	.152	.164	.176	.188	.199	.211	.223
.190		.048	.059	.071	.083	.095	.107	.119	.131	.143	.154	.166	.178	.190	.202	.214	.226
.200		.050	.063	.075	.088	.100	.113	.125	.138	.150	.163	.175	.188	.200	.213	.225	.238
.210		.053	.066	.079	.092	.105	.118	.131	.144	.158	.171	.184	.197	.210	.223	.236	.249
.220		.055	.069	.083	.096	.110	.124	.138	.151	.165	.179	.193	.206	.220	.234	.248	.261
.230		.058	.072	.086	.101	.115	.129	.144	.158	.173	.187	.201	.216	.230	.244	.259	.273
.240		.060	.075	.090	.105	.120	.135	.150	.165	.180	.195	.210	.225	.240	.255	.270	.285
.250	1/4	.063	.078	.094	.109	.125	.141	.156	.172	.188	.203	.219	.234	.250	.266	.281	.297
.260		.065	.081	.098	.114	.130	.146	.163	.179	.195	.211	.228	.244	.260	.276	.293	.309
.270		.068	.084	.101	.118	.135	.152	.169	.186	.203	.219	.236	.253	.270	.287	.304	.321
.280		.070	.088	.105	.123	.140	.158	.175	.193	.210	.228	.245	.263	.280	.298	.315	.333
.290		.073	.091	.109	.127	.145	.163	.181	.199	.218	.236	.254	.272	.290	.308	.326	.344
.300		.075	.094	.113	.131	.150	.169	.188	.206	.225	.244	.263	.281	.300	.319	.338	.356
.310		.078	.097	.116	.136	.155	.174	.194	.213	.233	.252	.271	.291	.310	.329	.349	.368
.3125	5/16	.078	.098	.117	.137	.156	.176	.195	.215	.234	.254	.273	.293	.313	.332	.352	.371
.320		.080	.100	.120	.140	.160	.180	.200	.220	.240	.260	.280	.300	.320	.340	.360	.380
.330		.083	.103	.124	.144	.165	.186	.206	.227	.248	.268	.289	.309	.330	.351	.371	.392
.340		.085	.106	.128	.149	.170	.191	.213	.234	.255	.276	.298	.319	.340	.361	.383	.404
.350		.088	.109	.131	.153	.175	.197	.219	.241	.263	.284	.306	.328	.350	.372	.394	.416
.360		.090	.113	.135	.158	.180	.203	.225	.248	.270	.293	.315	.338	.360	.383	.405	.428
.370		.093	.116	.139	.162	.185	.208	.231	.254	.278	.301	.324	.347	.370	.393	.416	.439
.375	3/8	.094	.117	.141	.164	.188	.211	.234	.258	.281	.305	.328	.352	.375	.398	.422	.445
.380		.095	.119	.143	.166	.190	.214	.238	.261	.285	.309	.333	.356	.380	.404	.428	.451
.390		.098	.122	.146	.171	.195	.219	.244	.268	.293	.317	.341	.366	.390	.414	.439	.463
.400		.100	.125	.150	.175	.200	.225	.250	.275	.300	.325	.350	.375	.400	.425	.450	.475
.410		.103	.128	.154	.179	.205	.231	.256	.282	.308	.333	.359	.384	.410	.436	.461	.487
.420		.105	.131	.158	.184	.210	.236	.263	.289	.315	.341	.368	.394	.420	.446	.473	.499
.430		.108	.134	.161	.188	.215	.242	.269	.296	.323	.349	.376	.403	.430	.457	.484	.511
.4375	7/16	.109	.137	.164	.191	.219	.246	.273	.301	.328	.355	.383	.410	.438	.465	.492	.520
.440		.110	.138	.165	.193	.220	.248	.275	.303	.330	.358	.385	.413	.440	.468	.495	.523
.450		.113	.141	.169	.197	.225	.253	.281	.309	.338	.366	.394	.422	.450	.478	.506	.534
.460		.115	.144	.173	.201	.230	.259	.288	.316	.345	.374	.403	.431	.460	.489	.518	.546
.470		.118	.147	.176	.206	.235	.264	.294	.323	.353	.382	.411	.441	.470	.499	.529	.558
.480		.120	.150	.180	.210	.240	.270	.300	.330	.360	.390	.420	.450	.480	.510	.540	.570
.490		.123	.153	.184	.214	.245	.276	.306	.337	.368	.398	.429	.459	.490	.521	.551	.582
.500	1/2	.125	.156	.188	.219	.250	.281	.313	.344	.375	.406	.438	.469	.500	.531	.563	.594
.510		.128	.159	.191	.223	.255	.287	.319	.351	.383	.414	.446	.478	.510	.542	.574	.606
.520		.130	.163	.195	.228	.260	.293	.325	.358	.390	.423	.455	.488	.520	.553	.585	.618
.530		.133	.166	.199	.232	.265	.298	.331	.364	.398	.431	.464	.497	.530	.563	.596	.629
.540		.135	.169	.203	.236	.270	.304	.338	.371	.405	.439	.473	.506	.540	.574	.608	.641
.550		.138	.172	.206	.241	.275	.309	.344	.378	.413	.447	.481	.516	.550	.584	.619	.653
.560		.140	.175	.210	.245	.280	.315	.350	.385	.420	.455	.490	.525	.560	.595	.630	.665
.5625	9/16	.141	.176	.211	.246	.281	.316	.352	.387	.422	.457	.492	.527	.563	.598	.633	.668
.570		.143	.178	.214	.249	.285	.321	.356	.392	.428	.463	.499	.534	.570	.606	.641	.677
.580		.145	.181	.218	.254	.290	.326	.363	.399	.435	.471	.508	.544	.580	.616	.653	.689
.590		.148	.184	.221	.258	.295	.332	.369	.406	.443	.479	.516	.553	.590	.627	.664	.701
.600		.150	.188	.225	.263	.300	.338	.375	.413	.450	.488	.525	.563	.600	.638	.675	.713
.610		.153	.191	.229	.267	.305	.343	.381	.419	.458	.496	.534	.572	.610	.648	.686	.724
.620		.155	.194	.233	.271	.310	.349	.388	.426	.465	.504	.543	.581	.620	.659	.698	.736
.625	5/8	.156	.195	.234	.273	.313	.352	.391	.430	.469	.508	.547	.586	.625	.664	.703	.742
.630		.158	.197	.236	.276	.315	.354	.394	.433	.473	.512	.551	.591	.630	.669	.709	.748
.640		.160	.200	.240	.280	.320	.360	.400	.440	.480	.520	.560	.600	.640	.680	.720	.760
.650		.163	.203	.244	.284	.325	.366	.406	.447	.488	.528	.569	.609	.650	.691	.731	.772
.660		.165	.206	.248	.289	.330	.371	.413	.454	.495	.536	.578	.619	.660	.701	.743	.784
.670		.168	.209	.251	.293	.335	.377	.419	.461	.503	.544	.586	.628	.670	.712	.754	.796
.680		.170	.213	.255	.298	.340	.383	.425	.468	.510	.553	.595	.638	.680	.723	.765	.808
.6875	11/16	.172	.215	.258	.301	.344	.387	.430	.473	.516	.559	.602	.645	.688	.730	.773	.816
.690		.173	.216	.259	.302	.345	.388	.431	.474	.518	.561	.604	.647	.690	.733	.776	.819
.700		.175	.219	.263	.306	.350	.394	.438	.481	.525	.569	.613	.656	.700	.744	.788	.831
.710		.178	.222	.266	.311	.355	.399	.444	.488	.533	.577	.621	.666	.710	.754	.799	.843
.720		.180	.225	.270	.315	.360	.405	.450	.495	.540	.585	.630	.675	.720	.765	.810	.855
.730		.183	.228	.274	.319	.365	.411	.456	.502	.548	.593	.639	.684	.730	.776	.821	.867
.740		.185	.231	.278	.324	.370	.416	.463	.509	.555	.601	.648	.694	.740	.786	.833	.879
.750	3/4	.188	.234	.281	.328	.375	.422	.469	.516	.563	.609	.656	.703	.750	.797	.844	.891
.8125	13/16	.203	.254	.305	.355	.406	.457	.508	.559	.609	.660	.711	.762	.813	.863	.914	.965
.875	7/8	.219	.273	.328	.383	.438	.492	.547	.602	.656	.711	.766	.820	.875	.930	.984	1.04
.9375	15/16	.234	.293	.352	.410	.469	.527	.586	.645	.703	.762	.820	.879	.938	.996	1.05	1.11
1.000	1"	.250	.313	.375	.438	.500	.563	.625	.688	.750	.813	.875	.938	1.00	1.06	1.13	1.19

The reduction of areas for holes or thicknesses of plates not listed, may be found by addition or multiplication. Thus for a 2 3/4" plate, multiply figure given for 11/16" plate by 4, or add figure given for 3/4" plate to twice that given for 1" plate.

DIMENSIONS AND WEIGHTS OF MACHINE BOLTS

DIMENSIONS



Diam. of Bolt	Bolt Head and Nut				Bolt Head	Nut	Thread Details									
	Square		Hexagon				Length of Bolt							No. of Thrds per Inch	Diam. at Root of Thread	Area at Root of Thread
	Diam. of Flats	Diam. of Corners	Diam. of Flats	Diam. of Corners	Height	Height	1″ to 2″	2 1/8 to 2 1/2	2 5/8 to 3″	3 1/8 to 4″	4 1/8 to 8″	8 1/8 to 12″	12 1/8 to 20″			
D	F	C	F	C	H	N	Length of Thread T									
1/4	1/2	11/16	1/2	5/8	1/4	1/4	3/4	3/4	7/8	7/8	1	1	1	20	.185	.027
3/8	11/16	1	11/16	13/16	3/8	3/8	3/4	3/4	7/8	7/8	1	1	1	16	.294	.068
1/2	7/8	1 1/4	7/8	1	7/16	1/2	1	1	1	1 1/4	1 1/4	1 1/2	1 1/2	13	.400	.126
5/8	1 1/16	1 1/2	1 1/16	1 1/4	9/16	5/8	1 1/4	1 1/4	1 1/4	1 1/4	1 1/2	1 3/4	2	11	.507	.202
3/4	1 1/4	1 13/16	1 1/4	1 7/16	5/8	3/4	1 1/2	1 1/2	1 1/2	1 1/2	1 3/4	2	2	10	.620	.302
7/8	1 7/16	2 1/16	1 7/16	1 11/16	3/4	7/8	1 1/2	1 3/4	1 3/4	1 3/4	2	2 1/4	2 1/4	9	.731	.419
1	1 5/8	2 5/16	1 5/8	1 7/8	13/16	1	...	1 3/4	1 3/4	1 3/4	2 1/4	2 1/2	2 1/2	8	.838	.551
1 1/8	1 13/16	2 9/16	1 13/16	2 1/8	15/16	1 1/8	...	...	2 1/4	2 1/4	2 1/2	3	3	7	.939	.693
1 1/4	2	2 13/16	2	2 5/16	1	1 1/4	...	...	...	2 1/2	2 3/4	3	3	7	1.064	.890
1 3/8	2 3/16	3 1/8	2 3/16	2 9/16	1 1/8	1 3/8	...	...	...	...	3 1/4	3 1/2	3 1/2	6	1.158	1.054
1 1/2	2 3/8	3 3/8	2 3/8	2 3/4	1 3/16	1 1/2	...	...	...	...	3 3/4	4	4	6	1.283	1.294
1 5/8	2 9/16	3 5/8	2 9/16	3	1 5/16	1 5/8	...	...	...	...	4	4 1/4	4 1/4	5 1/2	1.389	1.515
1 3/4	2 3/4	3 7/8	2 3/4	3 3/16	1 3/8	1 3/4	...	...	...	...	...	4 1/2	4 1/2	5	1.490	1.744
1 7/8	2 15/16	4 3/16	2 15/16	3 7/16	1 1/2	1 7/8	...	...	...	...	...	4 3/4	4 3/4	5	1.615	2.049
2	3 1/8	4 7/16	3 1/8	3 5/8	1 9/16	2	...	...	...	...	..	5	5	4 1/2	1.711	2.300
2 1/4	3 1/2	4 15/16	3 1/2	4 1/16	1 3/4	2 1/4	...	...	...	...	..	5 1/2	5 1/2	4 1/2	1.961	3.021
2 1/2	3 7/8	5 1/2	3 7/8	4 1/2	1 15/16	2 1/2	...	...	...	...	...	6 1/4	6 1/4	4	2.175	3.716
2 3/4	4 1/4	6	4 1/4	4 15/16	2 1/8	2 3/4	...	...	...	...	...	7	7	4	2.425	4 619
3	4 5/8	6 9/16	4 5/8	5 3/8	2 5/16	3	...	...	...	...	...	7 3/4	7 3/4	3 1/2	2.629	5.428
3 1/4	5	7 1/16	5	5 13/16	2 1/2	3 1/4	...	...	...	...	..	8 1/2	8 1/2	3 1/2	2.879	6.509
3 1/2	5 3/8	7 5/8	5 3/8	6 1/4	2 11/16	3 1/2	..	.	...	..	...	9 1/2	9 1/2	3 1/4	3.100	7.549

WEIGHTS PER HUNDRED WITH NUTS

Length of Bolt	SQUARE HEADS AND NUTS									HEXAGON HEADS AND NUTS					
	Diameter of Bolt in Inches									Diameter of Bolt in Inches					
	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1″	3/8	1/2	5/8	3/4	7/8	1″
1	4	7	11	15	22	37	56	...	...	10	19	33	52	...	...
1 1/4	4	7	11	16	23	39	59	...	...	11	20	34	54	...	...
1 1/2	5	8	12	17	24	41	62	...	...	12	22	36	57	...	...
1 3/4	5	8	13	18	26	43	64	...	...	12	23	38	60	...	...
2	5	9	14	19	27	45	67	101	144	13	24	40	63	93	132
2 1/4	6	9	15	20	28	47	71	104	150	14	26	43	66	97	137
2 1/2	6	10	15	21	30	49	74	109	155	15	27	45	69	101	143
2 3/4	6	10	16	22	31	51	77	113	161	16	29	47	72	105	148
3	7	11	17	24	33	54	80	117	167	16	30	49	75	109	154
3 1/2	7	12	18	25	35	58	86	126	178	18	33	54	82	118	165
4	8	13	20	28	38	62	92	134	189	19	35	58	88	126	176
4 1/2	9	14	21	30	41	66	98	142	198	21	38	62	94	134	186
5	10	15	23	32	43	71	104	151	209	23	41	66	100	143	197
5 1/2	10	16	25	34	46	75	111	159	220	24	44	71	106	151	208
6	11	17	26	36	49	79	117	168	232	26	46	75	112	160	219
6 1/2	..	..	28	38	52	84	123	176	243	27	49	79	119	168	230
7	..	..	29	40	55	88	129	185	254	29	52	84	125	177	241
8	..	..	32	45	60	97	142	202	276	32	58	92	137	194	264
9	..	..	34	49	65	105	154	218	298	35	63	100	149	210	285
10	..	..	..	53	71	114	167	235	320	..	68	109	162	227	307
12	..	..	..	61	82	131	192	269	364	..	80	127	187	261	352
14	..	..	..	..	93	148	217	303	409	..	91	144	212	295	396
1″ addition	1.4	2.2	3 1	4.3	5 6	8.7	12.5	17.0	22 3	3 1	5.6	8.7	12.5	17 0	22.3

TEMPERATURE CHART

Working Temperature and Colour Chart for Iron and Steel

Conversion Formulae $F^\circ = \frac{9}{5} C + 32^\circ$ $C^\circ = \frac{5}{9} (F - 32^\circ)$

Colour	Fahr.	Cent.	Fahr.	
	2770		2770	Approximate melting point of pure iron.
	2700		2700	Melting point of steels, depending on carbon and other contents which reduce the melting point as their percentage increases.
	2600	1426.5	2600	
	2500	1371	2500	
	2400	1315.5	2400	
	2300	1260	2300	Approximate melting point for Cast Iron.
White	2200	1204	2200	
	2100	1149	2100	Distortion of microscopic intergranular structure of rivets starts, resulting in intergranular rupture after driving.
				Rivets start to spit.
	2000	1093	2000	
Light Yellow	1975			
		1065.5	1950	**Do not exceed this temperature in heating rivets.**
	1900	1038	1900	
Lemon	1825			
	1800	982	1800	Proper temperature for driving rivets.
Orange	1725			
	1700	926	1700	
Salmon	1650			
	1600	872	1600	
Bright Red	1550		1550	Scaling starts.
	1500	816	1500	Range of temperatures for refining grey iron castings into malleable iron castings.
	1400	760	1400	
Cherry Red	1375			
			1350	Approximate critical temperature of tool steels. Colour brightens when cooling past this temperature and expansion takes place. A magnet reacts below but not at or above this temperature. Heat above here for quenching treatment.
	1300	704	1300	
Medium Cherry	1250			
	1200	648.5	1200	
Dark Cherry	1175			
	1100	593	1100	
Blood Red	1050			
	1000	537.8	1000	Maximum temperature at which fireproofed structural steel may carry A. I. S. C. designing stresses. **Do not use gun on Rivet below this temperature.**
Dark Red	900	482.2	900	
	800	426.7	800	Ultimate Strength approximately equal to normal temperature strength of structural grade steel.
	700	371.1	700	
Blue Heat				At this temperature steel is in brittle condition. Ultimate Strength is 25% to 30% greater than normal temperature strength of structural grade steel.
	600	315.6	600	
	500		500	
	400	204.4	400	
	300		300	
		100	212	
	200	93.3	200	Do no calking above this temperature.
	100	37.8	100	
	32	0	32	

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DECIMALS OF A FOOT

FOR EACH 1/16 OF AN INCH FROM 1/16 TO 12 INCHES

Fraction	Decimal	Fraction	Decimal	Fraction	Decimal	Fraction	Decimal
1/16	0.0052	3 1/16	0.2552	6 1/16	0.5052	9 1/16	0.7552
1/8	0.0104	3 1/8	0.2604	6 1/8	0.5104	9 1/8	0.7604
3/16	0.0156	3 3/16	0.2656	6 3/16	0.5156	9 3/16	0.7656
1/4	0.0208	3 1/4	0.2708	6 1/4	0.5208	9 1/4	0.7708
5/16	0.0260	3 5/16	0.2760	6 5/16	0.5260	9 5/16	0.7760
3/8	0.0313	3 3/8	0.2813	6 3/8	0.5313	9 3/8	0.7813
7/16	0.0365	3 7/16	0.2865	6 7/16	0.5365	9 7/16	0.7865
1/2	0.0417	3 1/2	0.2917	6 1/2	0.5417	9 1/2	0.7917
9/16	0.0469	3 9/16	0.2969	6 9/16	0.5469	9 9/16	0.7969
5/8	0.0521	3 5/8	0.3021	6 5/8	0.5521	9 5/8	0.8021
11/16	0.0573	3 11/16	0.3073	6 11/16	0.5573	9 11/16	0.8073
3/4	0.0625	3 3/4	0.3125	6 3/4	0.5625	9 3/4	0.8125
13/16	0.0677	3 13/16	0.3177	6 13/16	0.5677	9 13/16	0.8177
7/8	0.0729	3 7/8	0.3229	6 7/8	0.5729	9 7/8	0.8229
15/16	0.0781	3 15/16	0.3281	6 15/16	0.5781	9 15/16	0.8281
1	0.0833	4	0.3333	7	0.5833	10	0.8333
1 1/16	0.0885	4 1/16	0.3385	7 1/16	0.5885	10 1/16	0.8385
1 1/8	0.0938	4 1/8	0.3438	7 1/8	0.5938	10 1/8	0.8438
1 3/16	0.0990	4 3/16	0.3490	7 3/16	0.5990	10 3/16	0.8490
1 1/4	0.1042	4 1/4	0.3542	7 1/4	0.6042	10 1/4	0.8542
1 5/16	0.1094	4 5/16	0.3594	7 5/16	0.6094	10 5/16	0.8594
1 3/8	0.1146	4 3/8	0.3646	7 3/8	0.6146	10 3/8	0.8646
1 7/16	0.1198	4 7/16	0.3698	7 7/16	0.6198	10 7/16	0.8698
1 1/2	0.1250	4 1/2	0.3750	7 1/2	0.6250	10 1/2	0.8750
1 9/16	0.1302	4 9/16	0.3802	7 9/16	0.6302	10 9/16	0.8802
1 5/8	0.1354	4 5/8	0.3854	7 5/8	0.6354	10 5/8	0.8854
1 11/16	0.1406	4 11/16	0.3906	7 11/16	0.6406	10 11/16	0.8906
1 3/4	0.1458	4 3/4	0.3958	7 3/4	0.6458	10 3/4	0.8958
1 13/16	0.1510	4 13/16	0.4010	7 13/16	0.6510	10 13/16	0.9010
1 7/8	0.1563	4 7/8	0.4063	7 7/8	0.6563	10 7/8	0.9063
1 15/16	0.1615	4 15/16	0.4115	7 15/16	0.6615	10 15/16	0.9115
2	0.1667	5	0.4167	8	0.6667	11	0.9167
2 1/16	0.1719	5 1/16	0.4219	8 1/16	0.6719	11 1/16	0.9219
2 1/8	0.1771	5 1/8	0.4271	8 1/8	0.6771	11 1/8	0.9271
2 3/16	0.1823	5 3/16	0.4323	8 3/16	0.6823	11 3/16	0.9323
2 1/4	0.1875	5 1/4	0.4375	8 1/4	0.6875	11 1/4	0.9375
2 5/16	0.1927	5 5/16	0.4427	8 5/16	0.6927	11 5/16	0.9427
2 3/8	0.1979	5 3/8	0.4479	8 3/8	0.6979	11 3/8	0.9479
2 7/16	0.2031	5 7/16	0.4531	8 7/16	0.7031	11 7/16	0.9531
2 1/2	0.2083	5 1/2	0.4583	8 1/2	0.7083	11 1/2	0.9583
2 9/16	0.2135	5 9/16	0.4635	8 9/16	0.7135	11 9/16	0.9635
2 5/8	0.2188	5 5/8	0.4688	8 5/8	0.7188	11 5/8	0.9688
2 11/16	0.2240	5 11/16	0.4740	8 11/16	0.7240	11 11/16	0.9740
2 3/4	0.2292	5 3/4	0.4792	8 3/4	0.7292	11 3/4	0.9792
2 13/16	0.2344	5 13/16	0.4844	8 13/16	0.7344	11 13/16	0.9844
2 7/8	0.2396	5 7/8	0.4896	8 7/8	0.7396	11 7/8	0.9896
2 15/16	0.2448	5 15/16	0.4948	8 15/16	0.7448	11 15/16	0.9948
3	0.2500	6	0.5000	9	0.7500	12	1.0000

DECIMALS OF AN INCH

FOR EACH 1/64TH.

Fractions	Decimals	Fractions	Decimals
1/64	0.015625	33/64	0.515625
1/32	0.03125	17/32	0.53125
3/64	0.046875	35/64	0.546875
1/16	0.0625	9/16	0.5625
5/64	0.078125	37/64	0.578125
3/32	0.09375	19/32	0.59375
7/64	0.109375	39/64	0.609375
1/8	0.125	5/8	0.625
9/64	0.140625	41/64	0.640625
5/32	0.15625	21/32	0.65625
11/64	0.171875	43/64	0.671875
3/16	0.1875	11/16	0.6875
13/64	0.203125	45/64	0.703125
7/32	0.21875	23/32	0.71875
15/64	0.234375	47/64	0.734375
1/4	0.250	3/4	0.750
17/64	0.265625	49/64	0.765625
9/32	0.28125	25/32	0.78125
19/64	0.296875	51/64	0.796875
5/16	0.3125	13/16	0.8125
21/64	0.328125	53/64	0.828125
11/32	0.34375	27/32	0.84375
23/64	0.359375	55/64	0.859375
3/8	0.375	7/8	0.875
25/64	0.390625	57/64	0.890625
13/32	0.40625	29/32	0.90625
27/64	0.421875	59/64	0.921875
7/16	0.4375	15/16	0.9375
29/64	0.453125	61/64	0.953125
15/32	0.46875	31/32	0.96875
31/64	0.484375	63/64	0.984375
1/2	0.500	1″	1.000

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